THE EFFECT OF INVESTOR SENTIMENT ON SOVEREIGN RISK PREMIUMS

Master's Thesis
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Abstract of master's thesis

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Abstract

The question of whether investor sentiment affects asset prices has been actively debated in the finance literature. This master´s thesis examines the effect of investor risk appetite on asset returns in the market segment that has not received much attention in the existing literature; investment grade government bonds.

In order to identify the impact of investor sentiment, this study controls the effects of time-varying fundamentals by focusing on the yield spreads to Germany in 10-year government bonds of other triple-A-rated Eurozone countries. The main finding of the empirical analysis is that the sovereign yield spreads are positively related to the level of risk aversion.

This study applies fairly recent and novel measure for investor risk aversion, the equity variance premium that is obtained with a decomposition method developed by Bekaert and Hoerova, and Lo Duca (2013). The variance premium for European financial markets is defined as a difference between the squared VDAX index and an estimate of the conditional variance of the German stock market, the DAX index. The decomposition of the volatility index provides measures for investor risk appetite and expected stock market uncertainty which have been identified as important drivers of asset price dynamics in recent structural dynamic asset pricing literature.

The results suggest that during the times of low investor risk appetite, the sovereign yield spreads to Germany increase. This finding holds for both pre- and post-crisis periods and also when the identification assumption of constant fundamental based risk premium to Germany is relaxed by controlling the differences in CDS (credit default swap) prices.

Keywords investor sentiment, risk-aversion, asset pricing, yield spread, government bond

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Tiivistelmä

Markkinasentimentin ja arvopaperien hintojen välinen yhteys on ollut pitkään rahoitusmarkkinatutkimuksen mielenkiinnon kohteena. Tämä maisterintutkielma käsittelee sijoittajien riskinottohalukkuuden vaikutuksia matalan luottoriskin omaavien valtionlainojen hintoihin. Kyseinen markkinasegmentti on jäänyt aiemmissa tutkimuksissa verrattain vähälle huomiolle.

Tutkielman empiirinen analyysi keskittyy 10-vuoden valtionlainojen tuottoeroihin AAA-luottoluokituksen omaavien euromaiden ja Saksan välillä. Tällä tavoin pyritään kontrolloimaan ajassa muuttuvat fundamenttitekijät ja identifioimaan sijoittajien riskiaversion vaikutukset valtionlainojen tuottovaatimukseen. Tutkielmassa havaitaan että valtionlainojen tuottoerot ovat positiivisesti yhteydessä markkinoiden yleisen riskiaversion tasoon.

Tutkielma hyödyntää tuoretta mittaria sijoittajien riskinottohalukkuudelle, joka estimoidaan käyttämällä Bekartin, Hoerovan ja Lo Ducan (2013) kehittämää volatiliteetti-indeksihajotelmaa. Tässä menetelmässä Saksan osakemarkkinoiden riskiaversiota heijastava varianssiriskilisä määritellään neliöidyn VDAX-indeksin ja DAX-indeksin estimoidun ehdollisen varianssin erotuksena. Menetelmä tuottaa mittarit sekä sijoittajien riskinottohalukkuudelle että osakemarkkinoiden odotetulle epävarmuudelle, joiden merkitystä modernit rakenteelliset ja dynaamiset hinnoittelumallit ovat korostaneet arvopaperien hinnanmuodostuksessa.

Tutkimuksen mukaan matalan riskinottohalukkuuden aikoina valtioluottojen korkoerot suhteessa Saksaan kasvavat. Tämä tulos pätee sekä viimeisintä finanssikriisiä edeltäneenä että sitä seuranneena ajanjaksona. Positiivinen yhteys korkoerojen ja riskiaversion välillä säilyy myös silloin kun fundamenttiperusteisen tuottoeron sallitaan muuttua ajassa kontrolloimalla CDS (credit default swap)-hintojen erot suhteessa Saksaan.

Avainsanat markkinasentimentti, riskiaversio, arvopaperien hinnoittelu, valtionlaina

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1 Introduction

The question of whether investor sentiment affects asset prices has been actively debated in the finance literature. After the historical price run-up in the US stock markets and subsequent collapse in the late 1920´s, John Maynard Keynes argued that markets can be affected from investors' animal spirits, which move prices in a way unrelated to fundamentals. According to classical asset pricing theories, asset returns are determined by rational expectations on changes in economic fundamentals. In contrast, the behavioral branch of literature suggests that the sentiment and trading behavior of market participants significantly affect asset returns in financial markets (see e.g. Baker and Wurgler, 2007 and Brown and Cliff, 2004). Recently, structural dynamic asset pricing models, such as Campbell and Cochrane, 1999 and Bansal and Yaron, 2004, also identifies risk aversion and economic uncertainty as important drivers of asset price dynamics.

A bulk of empirical studies find that investor sentiment significantly affects stock returns (see e.g. Brown and Cliff, 2004, Brown and Cliff, 2005, Baker and Wurgler, 2006, Baker and Wurgler, 2007, Schmeling, 2009 and Baker et al., 2012). While the majority of studies focus on the stock markets, some authors such as Blommestein et al. (2012) and De Grauwe and Ji (2013) consider that during the latest European sovereign debt crisis the increase in yield spreads in sovereign bonds was more driven by market sentiment than expected fundamentals.

This master´s thesis examines the effect of investor risk appetite on asset returns in the market segment that has not received much attention in the existing literature; investment grade government bonds. In order to identify the impact of investor sentiment, this study controls the effects of time-varying fundamentals by focusing on the yield spread to Germany in 10-year government bonds of other triple-A-rated Eurozone countries. Compared to previous studies on determinants of sovereign yield spreads (see e.g. Schuknecht et al., 2010 and De Grauwe and Ji, 2013), this design does not require the inclusion of low frequency macroeconomic or fiscal variables, and hence it allows to conduct the analysis with daily data.

The identification strategy stems to the fact that investment grade sovereign bonds have been considered as the safest assets in the world (Fontana and Scheicher, 2016). Due to concave payoff pattern of the debt claim (Hong and Sraer, 2013), it could be expected that

the difference in default risk between Germany and triple-A-tranche Euro-sovereigns should not be much affected by idiosyncratic fiscal or macroeconomic developments. If the investor holds the bond to the maturity, the expected nominal return from the investment is likely to be certain. From the historical perspective it is extremely unlikely that a country with triple-A-rating ends up to default during the next 10 year period. In addition the analyzed countries have common monetary policy and hence, the yield spreads do not contain exchange rate risk. Intuitively this empirical design relates to Froot`s and Dabora`s (1999) study on mispricing between twin-companies.

This master´s thesis contributes to the existing literature by providing new evidence that the sentiment phenomena can be observed also in the asset class that is often considered as a safe haven in the European financial markets. The main finding of this study is that the sovereign yield spreads are positively related to the level of risk aversion, which is line with theoretical prediction of presented consumption based asset pricing model.

Previous studies often utilize volatility index (such VIX for US stock markets) as a proxy for investor sentiment (Bekaert and Hoerova, and Lo Duca, 2013). Recent literature, however, suggests that volatility index harbors information on both risk aversion and uncertainty (see e.g. Carr and Wu, 2009). This study applies fairly recent and novel measure for investor risk aversion, the equity variance premium that is obtained with a decomposition method developed by Bekaert and Hoerova, and Lo Duca (2013).

The variance premium for European financial markets is defined as a difference between the squared VDAX index and an estimate of the conditional variance of the German stock market, the DAX index. The decomposition of the volatility index provides a measures for investor risk appetite and expected stock market uncertainty. The descriptive validation of these measures shows that during the analyzed time period, from 2002 to 2014, both measures are highly correlated with the observed flight-to-quality and flight-to-liquidity tendencies. These phenome have been traditionally associated with changes in investor sentiment in the market place.

The results suggest that during the times of low investor risk appetite, the sovereign yield spreads to Germany increase. This finding holds for both pre- and post-crisis periods and also when the identification assumption of constant fundamental based risk premium to Germany is relaxed by controlling the differences in CDS (credit default swap) prices. The positive relationship between risk aversion and spreads seems to be robust and persistent during the analyzed time period from 2002 to 2014. Moreover, the estimated magnitude of the effect of investor sentiment is economically significant. For example, if the risk aversion

measure increases by one standard deviation from its average level, which is fairly common movement during the sample period, the average yield spread to Germany increases by 20 percent points. In relative terms, this increase would result over 5 percent points higher average sovereign borrowing costs compared to Germany for the analyzed triple-A-rated countries. In 2008, when the risk aversion reached its highest levels, the average impact of the investor sentiment was over 40 basis points which corresponds about 10 percent points higher sovereign borrowing costs compared to Germany in long maturity government bonds.

In order to study the causal link between risk aversion, uncertainty and spreads, the VAR analysis is also conducted. It is plausible that the regression analysis suffers from the endogeneity problem that might arise for example from the fact that the spreads could also reflect the expectations on the future of the euro system. It might be the case that the yield spreads in the Eurozone´s sovereign debt markets are affected from investor risk appetite and expected uncertainty in the German stock markets. The VAR analysis finds that there are causal relationship between yield spread and risk aversion, i.e. increase in risk aversion leads to higher yield spread. The magnitude of this effect is clearly higher compared to the OLS estimates.

Last it is studied whether the sentiment model that contains information on risk aversion and uncertainty provides better forecasts for yield spreads compared to simple AR(1) model. According to the results the sentiment model provides better predictions for the next day´s yield spreads only during the turbulent times. With monthly data frequency the sentiment model outperforms the AR(1) model also during the pre-crisis periods. The forecasting evaluations suggest that risk aversion and uncertainty have significant long run predictive power on spreads whereas in short run these measures do not provide valuable information for the forecasts.

The remainder of this thesis is organized as follows: the next reviews existing literature on the relationship between investor sentiment and asset prices and provides theoretical framework for the empirical analysis. Section 3 introduces the dataset and presents the decomposition method which results the measures for risk aversion and uncertainty from the VDAX index. Section 4 introduces the empirical strategy and results from regression- and VAR-analyzes and forecasting evaluations. Also internal and external validity and limitations of the study are shortly discussed. The last section provides a conclusion and suggestions for future research.

2 Theoretical motivation and literature review

This section reviews existing literature on the relationship between investor sentiment and asset prices. I present a simple consumption based asset pricing model that provides a framework for the empirical analysis on yield spreads in European sovereign debt markets. This model suggests that when the fundamental based risk premium between two risky assets is time-invariant, changes in observed spreads are determined by investor risk aversion and economic uncertainty. In addition, this section discusses about behavioral finance theories that deal with short-selling constraints and investor disagreement. These theories provide an alternative viewpoint for the relationship between investor sentiment and asset prices.

The link between asset valuation and investor sentiment is the subject of considerable debate in the finance literature (Brown & Cliff 2005). According to the traditional asset pricing theories, competition among rational investors leads to an equilibrium in which asset prices equal the rationally discounted value of expected future cash flows. These theories argue that the demands of irrational investors are offset by arbitrageurs and thus irrational behavior should not significantly affect prices (Baker & Wurgler 2006).

On the other hand, as early as 1936 John Maynard Keynes argued that investors' animal spirits can move prices in a way unrelated to fundamentals and cause wild fluctuations in the financial markets. More recently, Baker and Wurgler (2007) define investor sentiment as a belief about future cash flows or investment risks that is not justified by the facts at hand.

During the last decades behavioral finance literature has examined this phenomena by assuming that financial markets can be understood by using models in which some agents are not fully rational. This branch of literature has two building blocks: limits to arbitrage and psychology (Barberis and Thaler, 2003). Typically this literature suggests that sentiment affects the expectations on future cash flows and risks and thus has an effect on investment decisions and stock returns. Positive sentiment (also referred as excessive optimism or animal spirits) enforces investors´ confidence on their abilities to evaluate investment opportunities and makes them more willing to take risks. Brown and Cliff (2005) argue that sentiment is fairly persistent phenomena; people become more optimistic as they are reinforced by others joining on the bandwagon.

The behavior of financial asset prices in relation to consumption has been widely examined in the field of theoretical macroeconomics. This approach provides a cornerstone for the modern consumption based asset pricing theory. It assumes that investors are rational

in a sense that they maximize their expected utility given the utility function and budget constraint. I present this theory with a simple textbook framework.

Consider a complete market economy as in Lucas (1978) where representative investor makes portfolio choices over one risk-free and one risky assets, A_t and S_t respectively. By using the arbitrage condition, I illustrate how the difference between rates of returns of these assets, the equity premium, can be computed.

Representative investor chooses consumption stream $\{C_{t+i}\}_{i=0}^{\infty}$ in order to:

$$\max E_t \sum_{i=0}^{\infty} \beta^i U(C_{t+i}), \beta \in (0,1) \quad (1)$$

s.t

$$S_{t+1} + A_{t+1} = R_t^s S_t + R_t^a A_t + W_t - C_t$$

$$\lim_{i\to\infty} \frac{R_{t+1}^s S_{t+j}}{\prod_{j=1}^{i} R_{t+j}^s} = 0$$

$$\lim_{i\to\infty} \frac{R_{t+1}^a A_{t+j}}{\prod_{j=1}^{i} R_{t+j}^a} = 0$$

It is assumed that returns from risk-free and risky assets, R_t^a and R_t^s, follow first order Markov process that is exogenous to the investor. Moreover, the risk-free return R_{t+1}^a is known already in period t. W_t represents wage (or other) incomes that investor receives at time t and β is the subjective discount factor. The Bellman equation for this maximization problem can be written as:

$$V(R_t^s S_t, R_t^a A_t) = Max_{S_{t+1}, A_{t+1}} \{U(R_t^s S_t + R_t^a A_t + W_t - S_{t+1} - A_{t+1}) + \beta V(R_{t+1}^s S_{t+1}, R_{t+1}^a A_{t+1})\} \quad (2)$$

And the first order conditions are:

$$A_{t+1}: U'(C_t) = \beta E_t\{V_A'\{R_{t+1}^s S_{t+1}, R_{t+1}^a A_{t+1}\}\} \quad (3)$$

$$S_{t+1}: U'(C_t) = \beta E_t\{V_S'\{R_{t+1}^s S_{t+1}, R_{t+1}^a A_{t+1}\}\} \quad (4)$$

By differentiating the Bellman equation with respect to A_t and S_t, using envelope conditions for V_A and V_S, shifting one period forward, taking expectations and plugging back into first order conditions, we end to the well-known consumption beta-theory (see e.g. Campbell, 2003) :

$$R_{t+1}^{a} E_t \left\{ \frac{\beta U'(C_{t+1})}{U'(C_t)} \right\} = 1 \quad (5)$$

$$\beta E_t \left\{ R_{t+1}^{s} \frac{U'(C_{t+1})}{U'(C_t)} \right\} = 1 \quad (6)$$

By equating (5) and (6), the equity premium can be expressed as:

$$\frac{E_t\{R_{t+1}^{s}\} - R_{t+1}^{a}}{R_{t+1}^{a}} = Cov\{R_{t+1}^{s}, \frac{\beta U'(C_{t+1})}{U'(C_t)}\} \quad (7)$$

Equation 7 shows that if the investor is risk-averse, the risky asset must offer premium over the risk-free asset. The premium is proportional to the covariance of its return with respect to the marginal rate of transformation of consumption from today to tomorrow. Moreover, for equity premium to be positive, it must be that consumption itself is positively correlated with returns from risky asset (since $U'(C) < 0$). Higher the covariance between consumption and returns of risky asset, higher the premium should be in order for investor to hold risky asset.

By assuming CRRA (constant relative risk aversion) utility function ($U'(C) = C^{-\gamma}$, where γ is a coefficient for risk aversion) and denoting $\frac{C_{t+1}}{C_t} = \Delta C_{t+1}$, second order Taylor approximation for (7) yields following expression for the equity premium:

$$\log E_t\{R_{t+1}^{s}\} - logR_{t+1}^{a} = \gamma Cov(logR_{t+1}^{s}, log\Delta C_{t+1}) \approx$$
$$\gamma Corr(logR_{t+1}^{s}, log\Delta C_{t+1}) \sigma_{logR_{t+1}^{s}} \sigma_{log\Delta C_{t+1}} \quad (8)$$

Where $\sigma_{logR_{t+1}^{s}}$ denotes the variation of the return from the risky asset and $\sigma_{log\Delta C_{t+1}}$represents the variation in consumption growth (i.e. economic uncertainty).
According to the equation 8, if the performance of the risky asset is positively correlated with consumption growth (i.e. macroeconomic development or state of the economy), the equity premium is positive. The higher the risk aversion, the more sensitive the equity premium is to the co-movements of risky returns and consumption growth. In addition, the uncertainty on consumption growth and returns increase the required premium.

In order to motivate the empirical analysis of this thesis, I will extent this setup by assuming that there exists two risky assets in the economy, S^1 and S^2. The spread between two risky assets can be expressed as:

$$\log E_t\{R_{t+1}^{s1}\} - logE_t\{R_{t+1}^{s2}\}$$
$$\approx \gamma\sigma_{log\Delta C_{t+1}}(Corr(logR_{t+1}^{s1}, log\Delta C_{t+1})\sigma_{logR_{t+1}^{s1}} - Corr(logR_{t+1}^{s2}, log\Delta C_{t+1})\sigma_{logR_{t+1}^{s2}}) \quad (9)$$

Equation 9 shows that the spread between two risky assets depends on differences in asset specific fundamental factors, namely the correlations between pay-offs and consumption growth (i.e. the risk that arises from the macroeconomic sensitivity of the asset´s returns) and the deviations in asset returns. The more asset 1´s return is correlated with consumption growth and the higher is the uncertainty on of its return compared to asset 2, the higher is the spread between assets. In addition, investor´s risk aversion and the level of uncertainty on consumption (economic) growth enforce this fundamental-based premium.

This simple framework leads to very intuitive prediction; if the representative investor in highly risk-averse and there is high uncertainty on consumption growth, the required premium for safer asset is lower to riskier, compared to the case with low risk aversion and low economic uncertainty.

In this framework, risk aversion can be associated to the phenomena that behavioral economists call for investor sentiment. However, presented type of consumption based models typically assume that risk aversion is a constant parameter, which suggests that investor sentiment does not cause time variation to the asset prices. Due to empirically observed equity premium- and volatility-puzzles, Campbell (2003) suggests that a more realistic model for asset markets should contain high market price of risk that is time-varying and correlated with the state of the economy. In line with this view, recent structural dynamic asset pricing models have identified time-varying risk aversion and economic uncertainty as potential drivers of asset price dynamics (see e.g. Campbell and Cochrane 1999, Bansal and Yaron 2004 and Bekaert, Engstrom and Xing 2009).

For example Campbell and Cochrane (1999) present a model were the utility of a representative agent is a power function of the difference between consumption and so called habit term that is a slow-moving nonlinear average of past aggregate consumption. In this framework the agent becomes more risk-averse in bad times than in good times, because the consumption is lower relative to its past history. According to their model the equity premium can be explained with high average level of risk aversion and high stock market volatility.

Motivated by the above mentioned asset pricing models, the subsequent empirical analysis in section 4 is based on the reduced form version of the model (9) where investor´s risk-aversion γ is allowed to be time-varying γ_t. Moreover, it is assumed that the fundamental part of the risk premium between some AAA-rated Eurozone-country (*i*) and Germany (*G*) is time-invariant constant r_i:

$$Corr\left(logR_{t+1}^{si}, log\Delta C_{t+1}\right)\sigma_{logR_{t+1}^{s1}} - Corr(logR_{t+1}^{sG}, log\Delta C_{t+1})\sigma_{logR_{t+1}^{sG}} = r_i \qquad (10)$$

If this identification assumption holds, the yield spread for a country *i* at time *t* is an increasing function of constant country specific fundamental risk (r_i), risk aversion (γ_t) and economic uncertainty ($\sigma_{log\Delta C_{t+1}}$) :

$$Yield\ Spread_{it} = F(r_i, \gamma_t, \sigma_{log\Delta C_{t+1}}) \qquad (11)$$

Although the behavioral and structural (or rational) theories examine financial markets from different viewpoints, it can be seen that the new developments in the consumption based asset pricing models have converged the predictions of these literatures. Both model families recognize that changes in investor sentiment (or risk aversion) might affect asset prices.

The stock returns predictability in the cross-section is well established by the empirical literature. According to Campbell (2000) some firm characteristics, such as the book-to-market equity ratio, have predictive power on future returns. What causes this predictability continues to be debated in the literature. For example, Nagel (2005) suggests that the predictability might arise from the variation in rational expected returns across firms. An alternative explanation could be mispricing which results overpriced firms to generate lower returns than what have been expected whereas the returns of underpriced firms are higher. Overall, the observed predictability has been one of the key drivers for the developments of the both structural and behavioral asset pricing theories during the last decades.

From the rational viewpoint the main weakness of mispricing stories is that why these abnormal returns are not arbitraged away. Shleifer and Vishny (1997) highlight the role of limits to arbitrage for mispricing to persist in the presence of sophisticated

professional investors. Short-sales[1] constraints are often considered as one of the main limit to arbitrage in the behavioral finance literature (these constraints might arise for example from some institutional and psychological reasons, short selling can be costly or restricted by the authorities).

According to Miller (1977) stocks can become overpriced if some investors are too optimistic and short-sell constraints are binding. The assumption of binding short-sell constraints and investor disagreement are the core building blocks for various theories of bubbles in behavioral finance literature. For example, Miller (1977) and Chen, Hong and Stein (2002) show that disagreement combined with binding short-sales constraints lead to over-pricing as pessimists sit out of the market. Alternatively Harrison and Kreps (1978) and Scheinkman and Xiong (2003) consider that due to short-sell constraints investors might value the re-sell potential to other investor who might have higher valuation. This kind of frameworks generate a bubble or overpricing in which price exceeds the fundamental value. Empirical studies suggests that constraints on short-selling can lead to an optimism-bias in prices (see e.g. Chen et al., 2002; Jones and Lamont, 2002; Lamont, 2004; Reed, 2003).

Theoretical literature provides alternative mechanisms for the relationship between investor sentiment and asset prices. The behavioral branch of theories suggest that investors may form flawed beliefs and therefore incorrectly evaluate assets which causes deviations from the intrinsic values (see, e.g., De Long et al., 1990 and Kumar and Lee, 2006). If the mispricing gets corrected when sentiment wanes (or the economic fundamentals are revealed), this literature predicts that there is negative relationship between market sentiment and future asset returns. Qualitatively, consumption based asset pricing models with time-varying risk aversion also result similar relationship.

However, Brown and Cliff (2005) point out that the existence of systematic mispricing is hard to reveal because of the difficulty in examining the issue empirically. Unfortunately, there is not clear consensus on how the fundamental value of an asset should be measured. For this reason a researcher has a joint test for mispricing and model of discount rates which makes the identification of mispricing difficult (Barberis and Thaler, 2003). Correspondingly, the definition and proper measurement of investor sentiment are somewhat ambiguous and debated.

[1] Short-selling is a transaction where investor profits if the price of a stock decreases. Short seller borrows the stock and sell it expecting that the price is lower when the stock needs to be repurchased and returned to the lender.

The questions of whether the sentiment affects asset prices has been examined with various empirical strategies. Several studies that rely on the market level analysis find that investor sentiment has significant effect on stock returns in general (see e.g. Brown and Cliff 2004, Brown and Cliff 2005, Baker and Wurgler, 2006, Baker and Wurgler, 2007, Schmeling, 2009 and Baker et al., 2012). Another branch of behavioral studies show that the assumption of rational evaluation in asset pricing does not always hold by identifying individual cases which violates the law of one price (see e.g. Lamont and Thaler, 2003 (3Com's spinoff of Palm) and Froot and Dabora, 1999 (twin-companies)).

Traditionally researchers have relied survey-based indices for investor sentiment or market-based measures such as option implied volatilities, mutual fund flows and trading and IPO volumes. Recently, Da, Engelberg and Gao (2014) utilize daily internet search volume from millions of households to reveal market-level sentiment. They find that the search-based sentiment measure predicts short-term return reversals, temporary increases in volatility and mutual fund flows out of equity funds and into bond funds. In addition, studies that examine non-economic events find that sentiment-changing events cause changes in asset prices (see e.g. weather conditions; Hirshleifer and Shumway, 2003, sports; Edmans, Garcia, and Norli, 2007, seasonal affective disorder; Kamstra, Kramer, and Levi, 2003, aviation disasters; Kaplanski and Levy, 2010)

3 Measures for risk aversion and uncertainty

Consumption based asset pricing model in section 2 suggests that yield spread between two risky assets depends positively on difference in fundamental risk, the level of investor risk aversion and economic uncertainty. This section provides measures for the two latter determinants which are utilized in empirical analysis for sovereign yield spreads in section 4. Also data for empirical analyses is introduced.

3.1 Data

The dataset is unbalanced panel containing daily 10-year government bond yield spreads to Germany for the Eurozone countries which hold AAA-rating from Standard & Poors rating agency. These countries are namely Austria, Finland, France, Ireland, the Netherlands and Spain. The sample period starts at 01/03/2002 and ends at 10/10/2014, when the last country (Finland) lost its triple-A rating. A down-graded country is excluded from the sample day before the official announcement, giving 14053 observations. Data for 10-year government bond yields has been collected from Macrobond.

Measures for risk aversion and uncertainty are calculated by using daily values of VDAX index and daily realized variances (calculated from 5-minute intra-day returns) for DAX index. The data for VDAX and realized daily variance are collected from Macrobond and Oxford-Man Institute of Quantitative Finance Realized Library (Gerd et. al, 2009), respectively. Data for CDS prices has been collected from Macrobond.

3.2 Method

Behavioral finance literature and financial institutions have provided a variety of indicators for risk aversion and market sentiment (Coudert and Gex, 2008). This study utilizes fairly recent and novel measure for investor risk aversion, the equity variance premium. In this study, variance premium in German stock market is defined as a difference between the squared VDAX index and an estimate of the conditional variance of the stock market, the DAX index.

The VDAX index is the risk-neutral expected stock market variance for the DAX contract and is computed from a panel of options prices. The American equivalent, VIX for S&P500 index, has been considered as a fear index for asset markets (Whaley, 2000). These volatility indices reflect physical expected volatility (stock market uncertainty) and variance risk premium. The variance premium is based on the objective financial market information

and purifies option-implied volatility from the effect of uncertainty and physical volatility. For this reason the variance premium leaves a measure that is correlated with risk aversion (Bekaert, Hoerova, and Lo Duca, 2013).

Bollerslev, Tauchen and Zhou (2009) provide evidence on predictive power of the variance premium on stock returns. Bekaert, Hoerova, and Lo Duca (2013) find strong interactions between monetary policy and the variance premium which suggests that monetary policy may actually affect risk aversion in the market place. Subsequently, Bekaert and Hoerova (2014) find that the variance premium predicts stock returns whereas the conditional stock market variance predicts economic activity. Moreover, they find that the conditional variance has relatively higher predictive power for financial instability than does the variance premium.

In order to decompose the VDAX index into risk aversion and uncertainty measures, this study utilizes the approach developed by seminal paper of Bekaert and Hoerova, and Lo Duca (2013) for VIX index. The variance risk premium (*VP*) for German stock market is defined as:

$$VP_t = VDAX_t^2 - E_t[RV_{t+1}^{(22)}] \tag{12}$$

Here the VDAX is the implied option volatility of the DAX index for contracts with a maturity of one month, and $RV_{t+1}^{(22)}$ is the DAX realized variance measured over the next month (22 trading days) using 5 minute returns. Here the time index *t* denotes daily observations.

The squared VDAX can be interpreted as conditional return variance that uses risk-neutral probability measure, whereas the conditional variance is based on the actual physical probability measure. Theoretically the risk-adjusted measure shifts probability mass is shifted to states with higher marginal utility (bad states) and this implies that the variance premium will be increasing in the economy's risk aversion (Bekaert and Hoerova, 2014)

In the first phase of the decomposition the expected future realized variance needs to be estimated. Bekaert, Hoerova, and Lo Duca (2013) obtained the estimates by projecting future realized monthly variances (computed using squared 5-minute returns) onto the squared VIX, the dividend yield and the real three-month T-bill rate. They conducted a horserace between eight volatility forecasting models and ended up to following model for S&P500 index´s future realized variance:

$$RVAR_t = \alpha + \beta_1 VIX^2_{t-22} + \beta_2 RVAR^{(22)}_{t-1} + \varepsilon_t \quad (13)$$

The fitted value from the two-variable projection was their estimated conditional variance and their measure of "uncertainty." The difference between the squared VIX and the conditional variance they defined as a measure of "risk aversion", corresponding to *VP* in (12). Bekaert and Hoerova (2014) examined alternative specifications and suggested following forecasting model which adds the lagged weekly and daily variances to model 11:

$$RVAR_t = \alpha + \beta_1 VIX^2_{t-22} + \beta_2 RVAR^{(22)}_{t-1} + \beta_3 RVAR^{(5)}_{t-22} + \beta_4 RVAR^{(1)}_{t-22} + \varepsilon_t \quad (14)$$

In order to obtain $E_t[RV^{(22)}_{t+1}]$ for DAX index, I estimate the models 11 and 12 for German stock markets by using daily variances from 5-minute intra-day data. Based on the in- and out-off-sample forecasting abilities, the model 12 is selected for VDAX decomposition. The correlation coefficient (adjusted R-squared) between actual and forecasted variances is about 0.61 during the period 2002 to 2014. Figure 1 illustrates the developments in realized and forecasted variances (RVAR and RVARF, respectively) and the forecasting model seems to perform fairly well during the sample period.

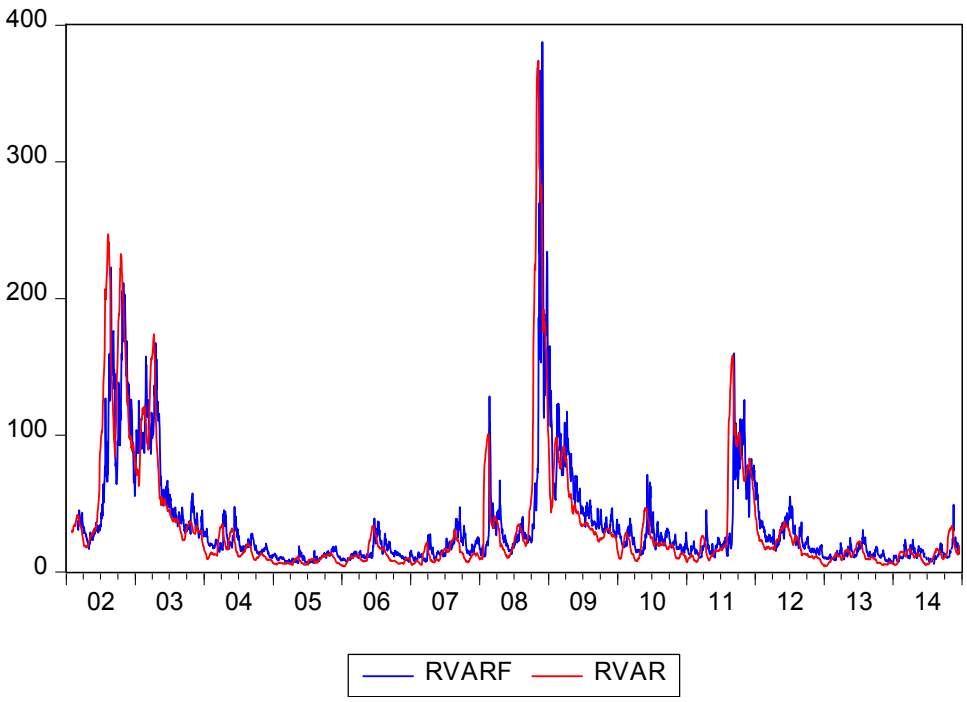

Figure 1. Actual (RVAR) and forecasted (RVARF) variance for German stock market.

3.3 Validating the measures

In this section I provide descriptive evidence for risk aversion and uncertainty measures and examine how these are related to some alternative measures and flight-to-quality and flight-to-liquidity phenomena.

Figure 2 shows the developments in risk aversion and uncertainty measures obtained from (10). The measure for uncertainty (RVARF) increases significantly during U.S corporate scandals and war of Iraq (2002 and 2003), after Lehman (autumn 2008) and during the different phases of European sovereign debt crisis (early 2010´s). The risk aversion measure (VP) follows fairly similar pattern. However, it seems that the peaks in risk aversion leads to some extent the corresponding peaks in uncertainty. In daily frequency, the correlation between the measures is low, only 0.04. Although the measures seem to have positive long run relationship, in short run the measures are almost orthogonal. VDAX index itself is more correlated with uncertainty than risk aversion, the correlations being 0.8 and 0.6, respectively.

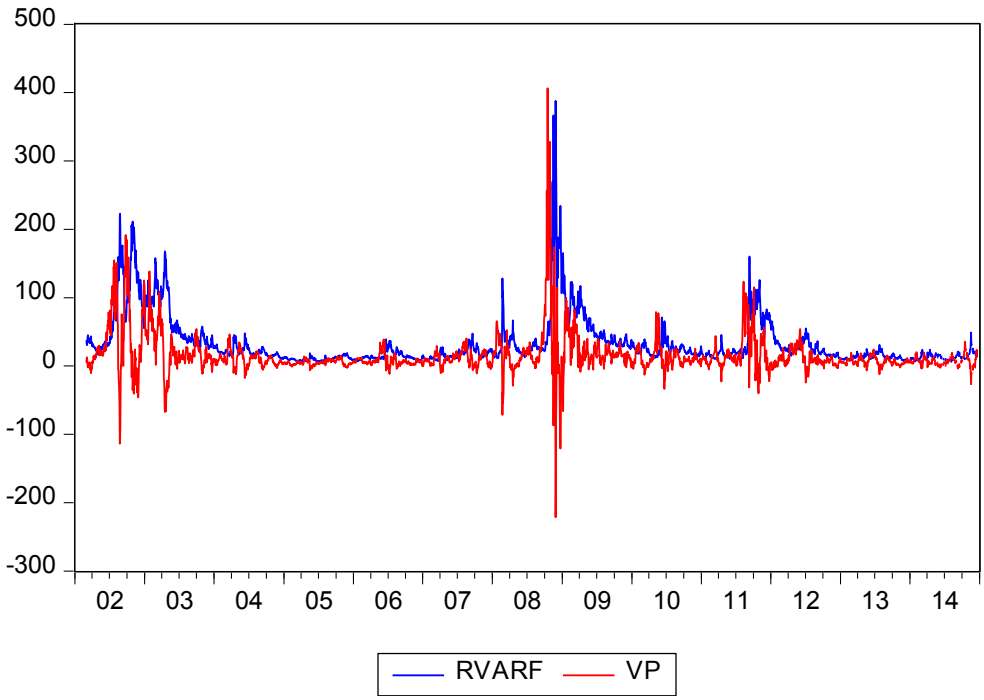

Figure 2. Risk aversion (VP) and uncertainty (RVARF) measures for German stock market.

Figure 3 illustrates the developments in RVARF and Economic Sentiment Index for the Eurozone (monthly frequency). The Economic Sentiment index is a composite indicator

published by European Commission. It is made up of five sectoral confidence indicators with different weights: Industrial confidence indicator, Services confidence indicator, Consumer confidence indicator, Construction confidence indicator and Retail trade confidence indicator. Stock market uncertainty and Economic sentiment index seem to be negatively correlated. During the high stock market uncertainty in Germany the Eurozone aggregate real economic sentiment is low. This is in line with the well-known observation that stock market volatility is high during the economic downturn (see e.g. Bloom 2009).

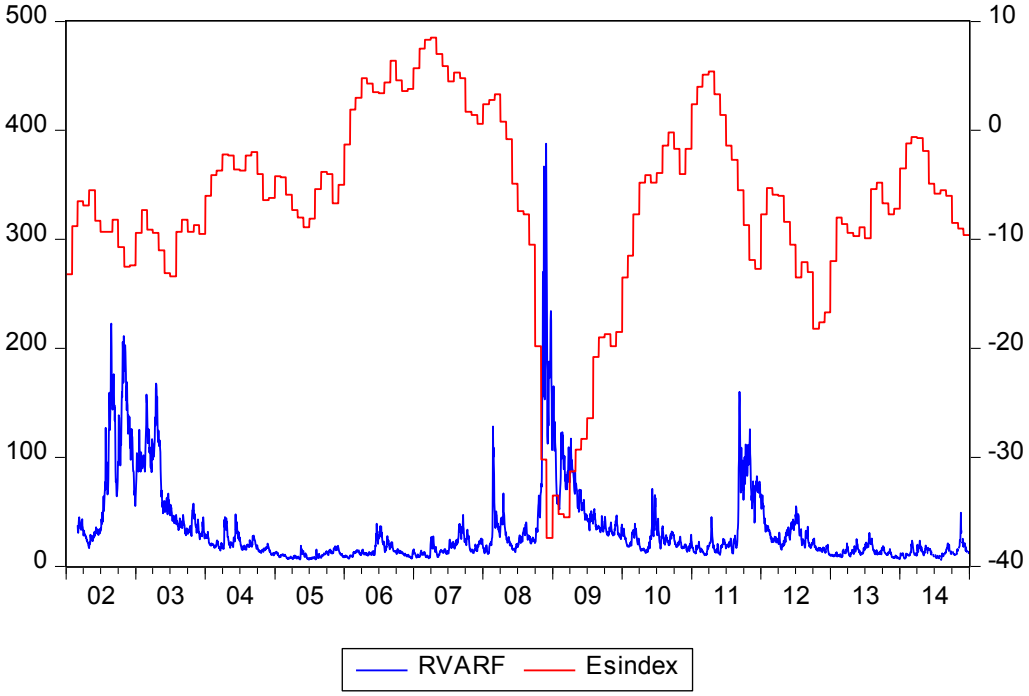

Figure 3. Economic Sentiment index for the Eurozone (Esindex, right scale) and uncertainty for German stock market (RVARF, left scale).

Figure 4 shows that the estimated variance premium for German stock market co-moves with European Central Bank´s (ECB) measure for global risk aversion indicator. However, the global risk aversion indicator is clearly more volatile. The indicator is constructed as the first principal component of five risk aversion indicators, namely Commerzbank Global Risk Perception, UBS FX Risk Index, Westpac's Risk Appetite Index, BoA ML Risk Aversion Indicator and Credit Suisse Risk Appetite Index. A rise in the indicator denotes an increase in risk aversion.

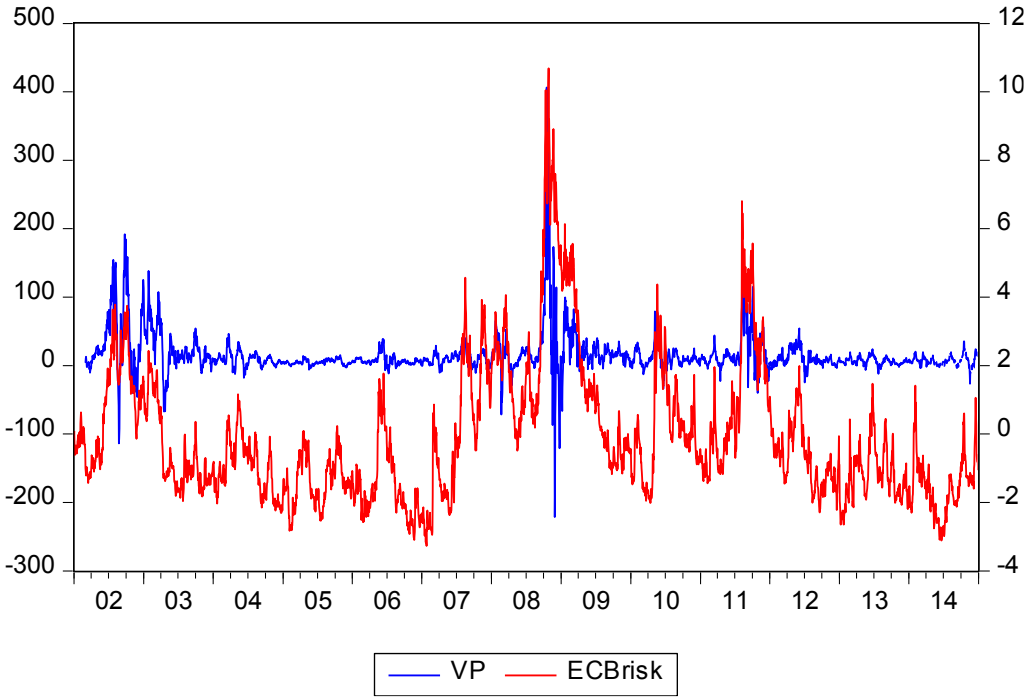

Figure 4. Risk aversion (VP, left scale) and European Central Banks measure for global risk aversion (ECBrisk, right scale).

It can be concluded that the estimated measures for variance premium (risk-aversion) and conditional variance (uncertainty) seems plausible. The forecasting model for realized variance performs fairly well and the measures have intuitive developments during the crises periods. Moreover, descriptive evidence suggests that VP and RVARF are correlated with alternative measures.

Next I examine the relationships between risk aversion and uncertainty measures to the phenomena which the literature has often connected to the investor sentiment, namely flight-to-liquidity and flight-to-quality. According to Baele et al (2013), a flight-to-liquidity arises when risk averse investment managers fear redemptions during high volatility periods. Then an increase in volatility may increase the demand for assets with high liquidity. Caballero and Krishnamurthy (2008) show that knightian uncertainty may lead investors to shed risky assets in favor of safe assets when aggregate liquidity is low. Increase in risk aversion leads to higher risk premiums, which in turn drives down the prices of risky assets (flight-to-quality).

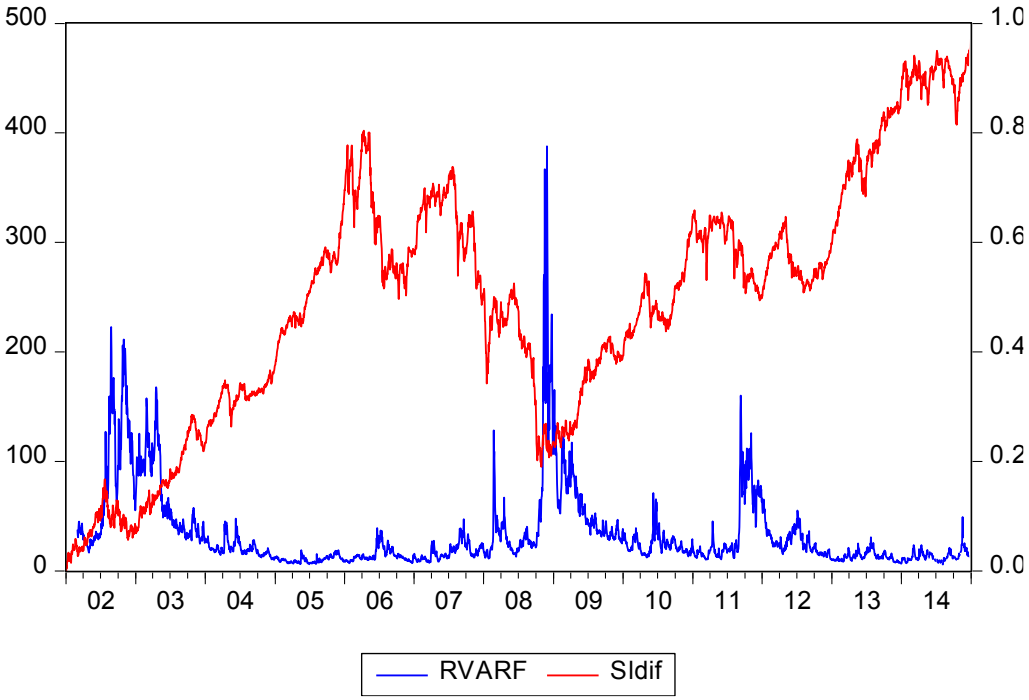

Figure 5. Uncertainty (RVARF, left scale) and difference between European small and large cap total return indices (Sldif, right scale, 02/01/2002=0).

The difference between small and large cap total return indices illustrates the flight-to-liquidity tendency in European stock markets. Figure 5 shows that during the high uncertainty periods, the relative returns from small and less liquid stocks decrease. This suggests that volatility increases demand for liquid stocks which increases prices and returns from these assets. Figure 8 illustrates similar relationship between risk aversion and flight-to-liquidity tendency.

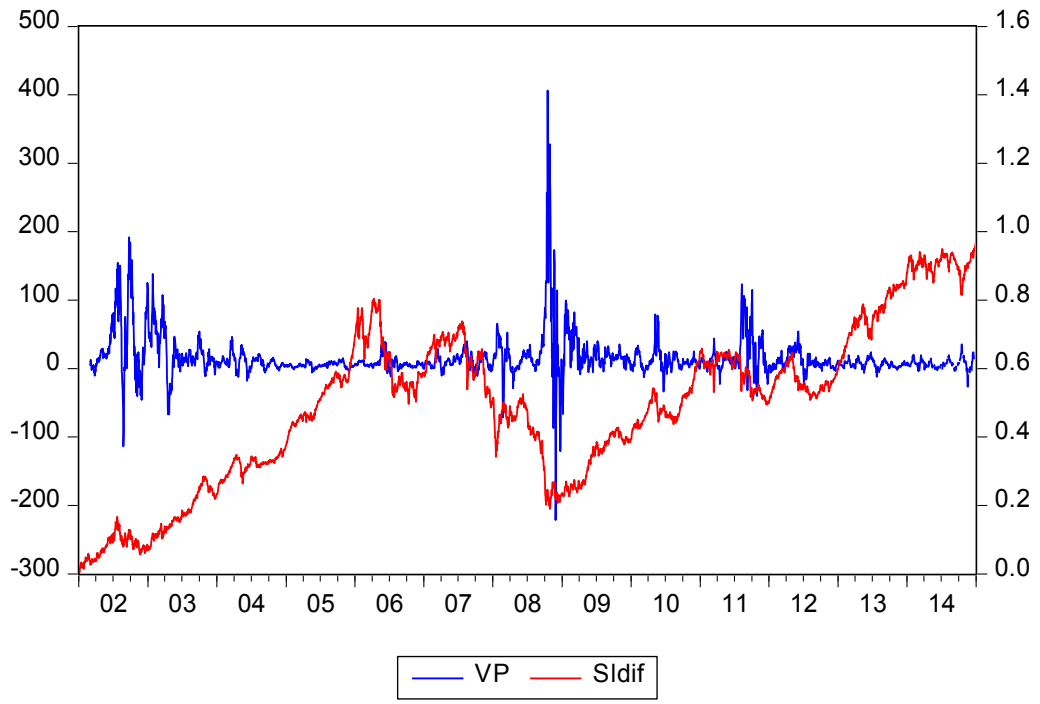

Figure 6. Risk aversion (VP, left scale) and difference between European small and large cap total return indices (Sldif, right scale, 02/01/2002=0).

Figures 7 and 8 suggest that uncertainty and risk aversion are positively related to the flight-to-safety tendency. Difference between total returns in BBB- and AAA-rated European corporate bond indices illustrates the investors' willingness to hold risky assets. Due to fact that the bonds are issued by relatively large companies, the measure probably lacks the flight-to-liquidity effect. During the high risk aversion and uncertainty periods investors shift their demand from riskier to safer bonds. After the latest financial crisis there is persistent shift in the difference. However, the negative correlation between series seems to hold during the post-crisis period.

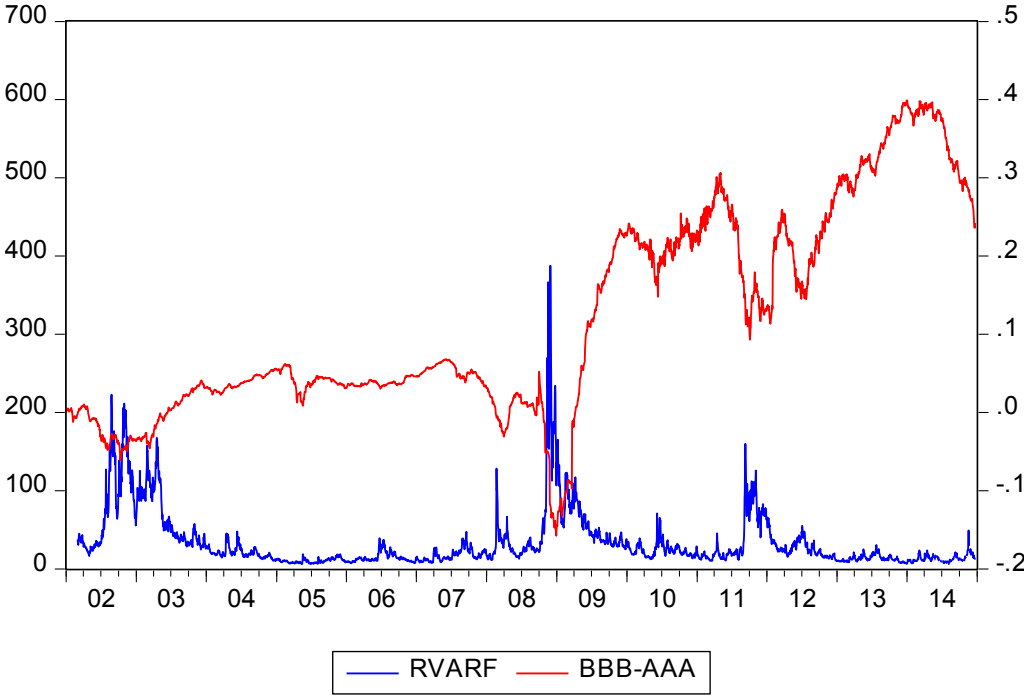

Figure 7. Uncertainty (RVARF, left scale) and difference between European BBB- and AAA-rated corporate bond total return indices (BBB-AAA, right scale, 02/01/2002=0).

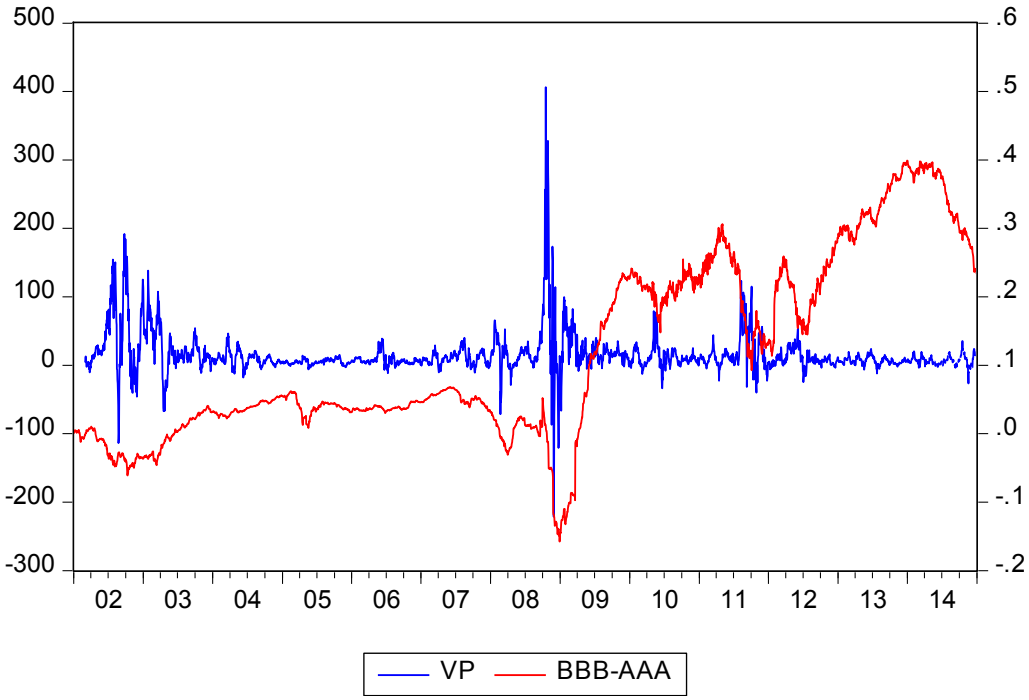

Figure 8. Risk aversion (VP, left scale) and difference between European BBB- and AAA-rated corporate bond total return indices (BBB-AAA, right scale, 02/01/2002=0).

Table 1: OLS-estimates for risk-aversion and uncertainty on flight-to-liquidity (Sldif) and flight-to-quality (BBB-AAA) measures (sample 2002-2014, 3320 observations, robust standard errors are reported in parenthesis, bolded values are statistically significant at 5 percent level)

	Flight-to-liquidity		**Flight-to-quality**	
	(1)	**(2)**	**(3)**	**(4)**
Constant	**0,630902**	**0,001990**	**0,179292**	**0,000574**
	(0,013927)	(0,000477)	(0,009038)	(0,000154)
VP	**-0,001777**	**-0,000019**	**-0,000741**	**-0,000015**
	(0,000247)	(0,00000561)	(0,000117)	(0,00000304)
RVARF	**-0,003268**	**-0,000009**	**-0,001498**	-0,000003
	(0,000302)	(0,00000414)	(0,000124)	(0,00000449)
AR(1)		**0,997677**		**0,998533**
		(0,000776)		(0,000588)
Adj. R-squared	0,363	0,999	0,216	0,999

The regression analysis supports previous descriptive evidence for the relationships between the measures and flight-to-quality and flight-to-liquidity phenomena. Regression 1 and 2 in table 1 estimate the effect of risk-aversion and uncertainty on difference between small and large cap indices. Both high risk-aversion and uncertainty measures are statistically significantly related to the flight-to-liquidity tendency. Regressions 3 and 4 suggest that similar conclusion applies also for the flight-to-quality (difference between returns in BBB and AAA-rated corporate bonds). However, in regression 4 the change in flight-to-quality tendency is enforced only by the risk aversion, the coefficient for uncertainty being statistically insignificant.

Regressions 1 and 3 show that compared to risk aversion, uncertainty is more related to the levels of both phenomena. However, regressions 2 and 4 that estimate the change in flight-to-liquidity and flight-to-quality tendencies suggest that risk aversion is more important determinant. This suggest that risk-appetite might be more important driver for the shifts in investor preferences in terms of liquidity and safety of the assets. However, the overall evaluation of the relative importance of the measures on the phenomena is somewhat ambiguous.

This section concludes that, in terms of alternative measures and observed shifts in investor preferences, both VP and RVARF react to the changes in investor sentiment and expected uncertainty in the European financial markets. Next section studies whether these measures can explain sovereign yield spreads in triple-A-rated Eurozone countries.

4 Estimating the effect of investor sentiment on sovereign yield spreads

The vast majority of previous empirical studies on investor sentiment and asset prices is based on the evidence from US stock markets (Schmeling 2009). This master thesis contributes to the existing literature by studying the effects of sentiment phenomena in the asset class that is often considered as a safe haven in the European financial markets; the triple-A-rated long maturity government bonds. Some authors (see e.g. De Grauwe and Ji, 2013) consider that during the Euro crisis, many sovereign borrowers in the Eurozone have paid significant risk premiums that cannot be justified by fiscal or macroeconomic fundamentals. This section examines whether these premiums are related to the levels of aversion and uncertainty in the Eurozone financial markets.

Empirical studies that examine whether some asset is mispriced to its fundamentals due to investor sentiment face significant challenges. For example, in a panel framework all relevant cross-section specific fundamental factors need to be controlled. In practice, it is hard to estimate plausible counterfactual scenario that answers to the question; what would have been the price of some asset if the sentiment in the market place would have been different? In addition the definition and measurement for sentiment are probably always somewhat questionable. For example, interpretation of the coefficient of simple volatility index is ambiguous since, in theory, it contains information on both risk aversion and stock market uncertainty.

By keeping these issues in mind, the analysis in this section aims to control the effects of time-varying fundamentals by focusing on yield spreads to Germany in other triple-A-rated Eurozone countries. Intuitively this empirical design is related to Froot`s and Dabora`s (1999) study on mispricing between twin-companies. Compared to other studies on sovereign yield spreads (see e.g. Schuknecht et al., 2010 and De Grauwe and Ji, 2013), this design does not require the inclusion of macroeconomic or fiscal variables and it allows to conduct the analysis with higher data frequency. In addition, this analysis utilizes VDAX-decomposition (from the previous section) that enables to separate the impacts of risk aversion and uncertainty on yield spreads.

The empirical analysis is threefold. First, regression analysis studies whether the yield spreads to Germany are related to the estimated risk aversion and uncertainty measures. Second, the sign of the causality is examined in VAR framework. Last the forecasting ability of the measures on yield spreads is studied.

4.1 Identification and empirical strategy

This study is conducted with 10-year government bonds issued by Eurozone countries which hold triple A-rating from Standard & Poors rating agency. According to Standard & Poors, an obligor rated AAA (highest issuer credit rating assigned by S&P Global Ratings) has extremely strong capacity to meet its financial commitments. The five key factors that form the foundation of their sovereign credit analysis are institutional effectiveness and political risks, economic structure and growth prospects, external liquidity and international investment position, fiscal performance and flexibility (as well as debt burden) and monetary flexibility (Standard & Poors, 2011).

The rationale for the identification strategy stems to the fact that investment grade sovereign bonds have been considered as the safest assets in the world. The lack of defaults among developed country governments underpinned the widely used assumption that government bonds provide a good proxy for the long-horizon risk-free rate (Fontana and Scheicher, 2016). It could be expected the difference in default risk between Germany and triple-A-tranche Euro-sovereigns should not be much affected by fiscal or macroeconomic developments. If the investor holds the bond to the maturity, the expected nominal return from the investment is likely to be certain. From the historical perspective it is extremely unlikely, although possible, event that a country with triple-A-rating ends up to default during the next 10 year period.

Eurozone countries in general, are fairly similar with respect to economic fundamentals; countries locate in the same geographical area, share similar economic and institutional structures and the economies are highly inter-connected. Due to single currency, countries have common monetary policy and hence, the yield spreads do not contain exchange rate risk. Moreover, the sovereign risk premiums converged rapidly after the introduction of the single currency, which could be interpreted as some kind of expected joint liability of government debts in the union.

The empirical evidence on the role of fiscal and economic fundamentals determining the realized sovereign bond spreads is mixed. Some papers attribute the importance of sovereign's fiscal position for risk premiums (e.g., Codogno et al., 2003; Schuknecht et al., 2010; Aizenman et al., 2013). In contrast, authors such as Favero et al. (2010) and Manganelli and Wolswijk (2009) consider that bond yield spreads are significantly affected by international factors that reflect global investor risk aversion. Blommestein et al. (2012)

and De Grauwe and Ji (2013) argue that during the European sovereign debt crisis the increased risk premiums are mostly driven by market sentiment.

The main difference between German and other triple-A Eurozone government bonds is that the German bonds are considered as the benchmark in the Eurozone. Like US Treasuries, the Swiss franc, the Japanese Yen and gold, German Bund have had a safe haven status in the global financial markets (Santis, 2012) Generally the yield spreads to Germany have been positive. This has been the case since German bonds are the most liquid ones and investor pays smaller transaction and information costs when buying German bonds compared to other Euro sovereigns. It is plausible to expect that the fundamental based yield spread to Germany is positive although fairly time-invariant. Due to fact that debt claim´s up-side payoffs are capped at some constant, the payoff pattern is concave in the investor beliefs about fundamentals (Hong and Sraer, 2013).

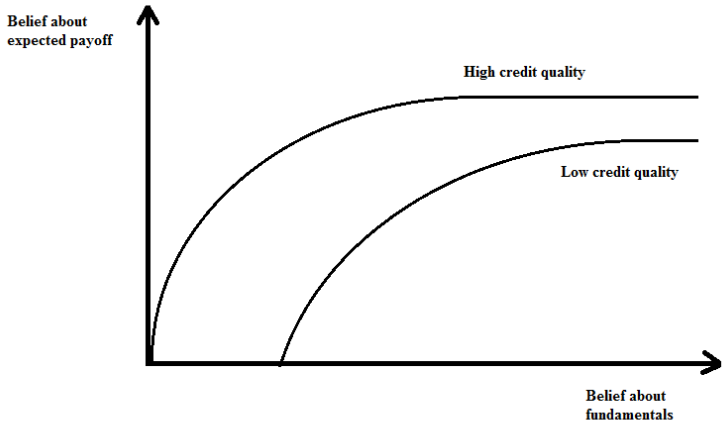

Figure 9. Expected payoffs from high and low credit quality bonds with respect to expected economic fundamentals.

Figure 9 illustrates the differences between high and low risk debt claims´ payoff patterns with respect to expected state of the economy. Due to concave payoff pattern, the value of the safe asset is less affected by the fundamentals compared to the riskier one. It can be assumed that the Eurozone countries holding the best credit rating have fairly similar payoff patterns to fundamentals. Moreover, if it is assumed that AAA-countries won´t default under any circumstances, then the payoff patterns are vertical to economic fundamentals.

Recall that the consumption based asset pricing model in section 2 suggests that yield spread between two risky assets depends positively on difference in fundamental risk, the level of investor risk aversion and economic uncertainty (equation 9). Therefore, the

empirical analysis requires two identification assumptions. First, the fundamental based risk premiums to Germany should be constant (equation 10). Second, the estimated measures for risk aversion and uncertainty, VP_t and $RVARF_t$ respectively, should correspond their theoretical counterparts γ_t and $\sigma_{log\Delta C_{t+1}}$.

If these assumptions hold, the yield spread for country *i* at time *t* is an increasing function of constant country specific fundamental risk, variance premium and conditional variance:

$$Yield\ Spread_{it} = F(r_i, VP_t, RVARF_t) \tag{15}$$

This section studies whether these measures have explanatory power on observed yield spreads as the theoretical motivation suggests. The estimated baseline model is:

$$Yield\ Spread_{it} = \alpha + \beta_1 VP_t + \beta_2 RVARF_t + \varepsilon_{it} \tag{16}$$

Where α is constant and ε_{it} is the error term.

Although the empirical analysis is based on consumption based asset pricing model, it should acknowledged that also behavioral theories can lead to the corresponding conclusions for the role of risk aversion. In the presence of binding short-sales constraints country *i`s* bond can get over-priced as pessimists sit out of the market, which leads smaller spread to Germany when risk aversion is low. Alternatively, during the time of decreasing risk aversion investors might value the potential to re-sell at a higher price to someone with a higher valuation due to binding short-sales constraints which also decreases the spread. According to both arguments, high sentiment combined with investor disagreement and short-selling constraints, can generate a bubble or overpricing in which the yield of country *i´s* bond is below its fundamental value r_i.

Previous studies suggest that there are significant limits to arbitrage in European sovereign debt markets, which makes the above mentioned behavioral mechanism plausible. For example, Fontana and Scheicher (2016) observe a relationship between the derivatives market and the underlying cash market characterized by sizable deviations from the no-arbitrage relationship. They show that short-selling frictions explain the persistence of positive basis deviations. Duffie (2010) reports that even during the latest financial crisis, the short positions were not common in the Eurozone´s sovereign debt markets. For example

the ratio of net CDS positions to Finnish government debt was under three percent. However, the speculation with naked CDSs and short bond positions were associated to the turbulence in the European bond market. In 2010, Germany prohibited naked CDSs of euro-denominated sovereign bonds and naked short sales[2] based on those bonds. The regulation aimed to drive down the rising bond yields and suppress the volatility in the market (Pu and Zhang 2012).

As a robustness check, it is studied whether the baseline results hold when the assumption of constant fundamental based risk premium is relaxed. This is done by controlling differences in CDS prices relative to Germany. A CDS contract protects investor against the default of the issuing sovereign. The premium which the protection buyer pays to the protection seller is determined in CDS market and reflects the expected default risk of the respective country (see e.g. Aizenman et al., 2013). Fontana and Scheicher (2016) find that CDSs correlate with country-specific economic covariates. In this sense, differences in CDS prices between Germany and other triple-A Eurozone countries provide a market based proxy for differences in expected default risk (i.e. in fiscal and macroeconomic fundamentals). Compared to actual fiscal and macroeconomic fundamentals, the main benefit of CDS data is that it available in a daily frequency. Unfortunately, when CDS prices are controlled, the number of observations decreases. This is due to fact that the CDS prices are available for the majority of analyzed sovereigns from 2006 or 2007 onwards.

[2] Naked short selling is a case of short selling without first arranging a borrow.

4.2 Descriptive evidence

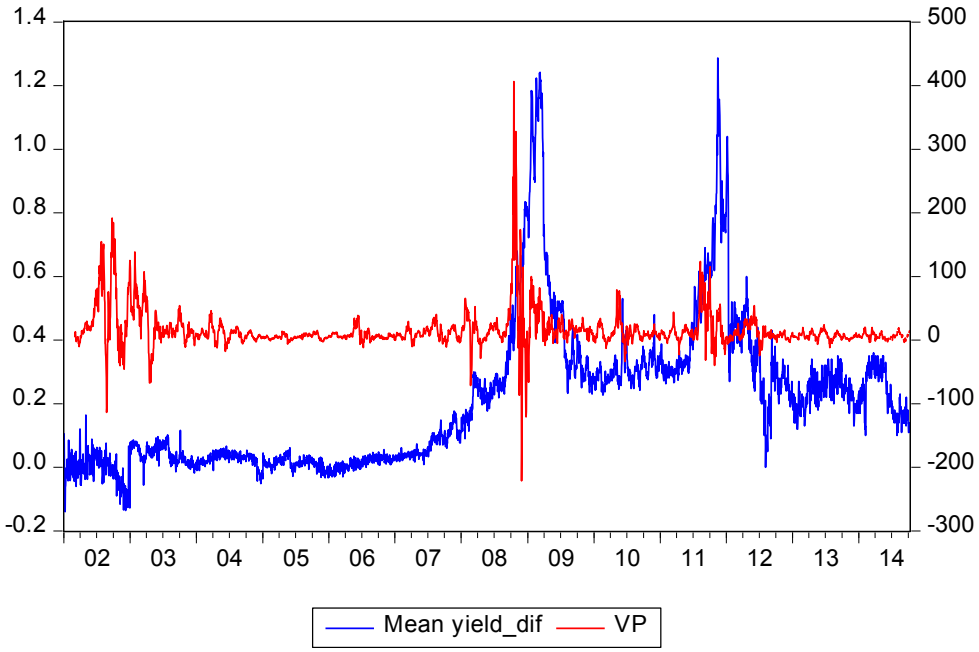

Figure 10. Average yield spread to Germany in AAA-rated Eurozone countries (right scale) and risk aversion (left scale).

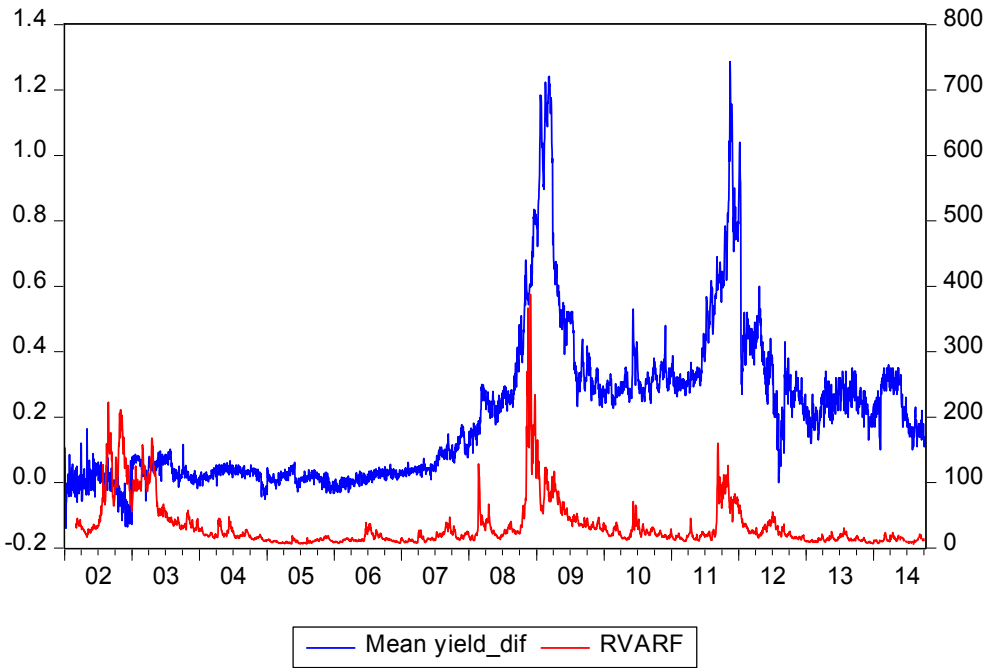

Figure 11. Average yield spreads to Germany in AAA-rated Eurozone countries (right scale) and uncertainty (left scale).

Figures 10 and 11 illustrate the developments in average yield spread and risk aversion and uncertainty measures. During the period 2002 to 2007 sovereign risk was almost equally

priced in the Eurozone, the yields spreads to Germany being near zero. In early 2008 the spreads increased rapidly breaching the 1 percent (100 basis point) level in May 2009 and November 2011. The low levels in spreads coincide with low levels in risk aversion and uncertainty measures. In addition, peaks in risk aversion seem to lead peaks in spread whereas the developments in spreads and uncertainty are more coincident.

Table 2: Descriptive statistics, yield spread to Germany, risk aversion and uncertainty, whole sample

	Spread	VP	RVARF
Mean	0,18	16,45	36,18
Median	0,07	9,21	21,22
Maximum	2,82	406,23	387,72
Minimum	-0,20	-221,29	5,88
Std. Dev.	0,27	33,29	40,40

Table 3: Average spreads to Germany, correlations between spreads, risk aversion and uncertainty, period when a country is included to the sample

Country	Spread	VP	RVARF	Time period	
Austria	0,25	0,09	0,28	1.3.2002	12.1.2012
Finland	0,18	0,14	0,30	1.3.2002	9.10.2014
France	0,17	0,05	0,20	1.3.2002	12.1.2012
Ireland	0,15	0,20	0,37	1.3.2002	27.3.2009
Netherlands	0,13	0,11	0,28	1.3.2002	12.1.2012
Spain	0,11	0,26	0,72	12.3.2004	9.1.2009
Average	0,17	0,14	0,36		

Table 2 shows that the average yield spread has been about 18 basis points (0,18 percent) and the spreads have been varied between 7 and 280 basis points. Moreover, table 3 reports that the average spreads have been fairly similar in individual countries, which suggests that the country specific heterogeneity in economic fundamentals does not lead to significantly different sovereign risk premium in the triple A-tranche. For example in 2005 government debt-to-GDP-ratios varied from 32 (Ireland) to 82 (France) percent. This finding supports the identification assumption of concave pay-off-pattern.

One might consider the magnitudes of the yield spreads as economically insignificant at the first sight. However, taking into account the fact that the average yield in German 10-

year government bonds has been about 320 basis points during the sample period, the spreads (in relative terms) have been significant from the sovereign borrowing viewpoint.

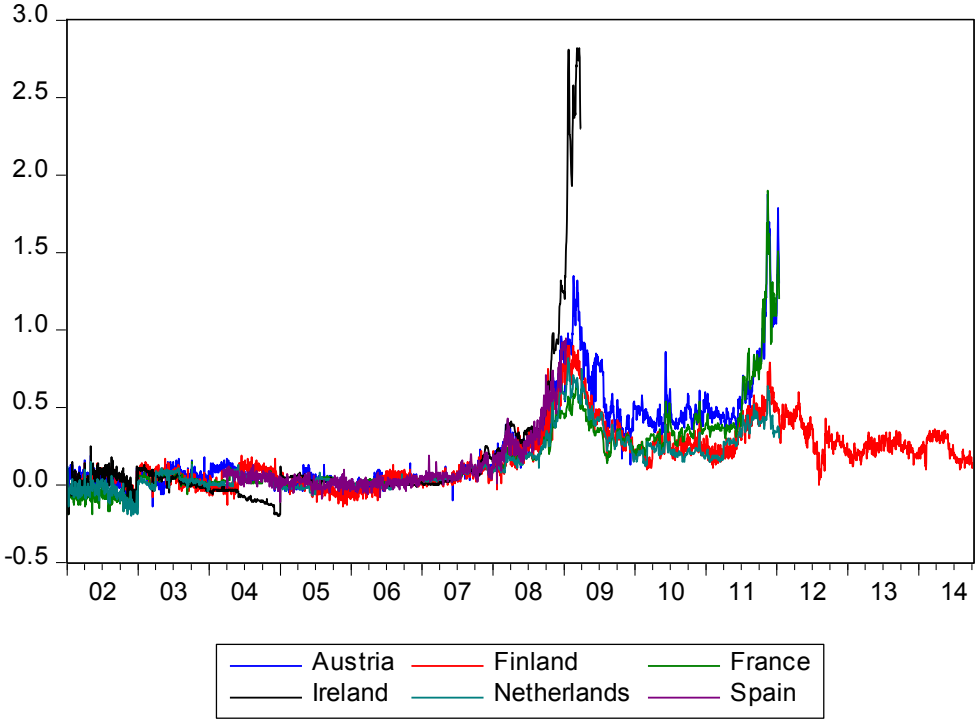

Figure 12. Spreads in individual AAA-rated countries.

As mentioned earlier, the data is unbalanced panel. Ireland and Spain lost their AAA-rating during the aftermath of the latest financial crisis whereas Austria, France and the Netherlands were downgraded in early 2012. During the last two years of the sample period, Finland was the only country in the Eurozone (in addition to Germany) that held its triple-A rating.

Figure 12 shows that the yield spreads follow similar pattern in all AAA-rated countries during the sample period. On the other hand there can be seen clear anticipation in spreads of Ireland, Austria and the Netherlands before the downgrading whereas corresponding development cannot be observed for Spain, France and Finland. CDS prices, however, help to control the possible effects of anticipated idiosyncratic changes in default risk before the rating event.

Simple correlations in table 3 suggest that spreads are positively related to the risk aversion and uncertainty measures, the average correlation coefficients being 0,14 and 0,36, respectively. The correlations between investor sentiment and spreads are highest in Spain and Ireland and lowest in France and Austria.

4.3 Baseline results

This section provides OLS estimates for risk aversion on yield spreads controlling the level of uncertainty. It is studied whether the risk aversion and uncertainty measures have explanatory power on observed yield spreads as the theoretical motivation suggests.

As a robustness check, I allow the fundamental part of risk premium to be time varying by controlling the spreads with differences in CDS prices to Germany. In that exercise it is assumed that CDS prices reflect only the default risk and are not affected by uncertainty or risk aversion (i.e. CDS is considered as an insurance).

In addition, the corresponding analysis is conducted with different subsamples of the data. Several studies (see e.g. Ureche-Rangau and Burietz, 2013, Acharya, Dreschler and Schnabl, 2011 and Candelon and Palm, 2010) highlight the role of the feedback loop between the governments and national banking sectors during the European sovereign debt crisis. Especially for Ireland and Spain this is relevant issue since the fiscal stance of these countries deteriorated significantly and rapidly, when governments attempted to save their banking systems during the financial crisis. This gives a rationale to examine whether the baseline results hold when Ireland and Spain are excluded from the sample. In addition, it is studied whether the results change when the crises periods (the latest financial crisis and the European sovereign debt crisis) are excluded. This sample period also omits downgrading activities.

Table 4: OLS coefficients for risk aversion (VP), uncertainty (RVARF), lagged yield spread (AR(1)) and difference in CDS price on yield spread and corresponding p-values (based on White heteroscedasticity robust standard errors, bolded values are statistically significant at 5 percent level)

	Whole sample			Ireland and Spain excluded			Before Lehman		
Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Constant	**0,08646**	0,00019	**0,12361**	**0,12087**	0,00114	**0,13172**	**0,05635**	**0,00366**	**-0,02338**
	(0,024821)	(0,000668)	(0,033883)	(0,004663)	(0,000763)	(0,005646)	(0,006138)	(0,001138)	(0,011748)
VP	**0,00100**	**0,00006**	**0,00110**	**0,00062**	**0,00005**	**0,00119**	0,00003	**0,00002**	**0,00272**
	(0,000278)	(0,00000713)	(0,000182)	(0,00015)	(0,0000237)	(0,000195)	(0,000116)	(0,00000743)	(0,000373)
RVARF	**0,00203**	**0,00002**	**0,00187**	**0,00150**	0,00002	**0,00228**	-0,00019	**-0,00002**	**0,00416**
	(0,000387)	(0,00000666)	(0,000537)	(0,000141)	(0,0000149)	(0,000184)	(0,000136)	(0,0000085)	(0,000629)
AR(1)		**0,99203**			**0,98743**			**0,93760**	
		(0,004832)			(0,004155)			(0,016344)	
CDS_dif			**0,00682**			**0,00592**			**0,00587**
			(0,00118)			(0,000154)			(0,001133)
Adjusted R-squared	0,11	0,98	0,73	0,07	0,97	0,65	0,01	0,88	0,58
Observations	14103	14103	7996	10996	10996	6781	9706	9706	3599

Table 3 reports the results of the regression analysis. Regression 1 corresponds to the equation 16 that is derived from the presented theoretical model whereas regressions 2-9 provide robustness checks. Regressions 1-3 utilize the whole sample, regressions 4-6 exclude Ireland and Spain and regressions 7-9 analyze the pre-crisis period (time before the bankruptcy of Lehman Brothers in 19. September 2008). Due to unbalanced nature of the data, different sample periods give different weights for each country (in regressions 1-3 Finland has the largest weight whereas in regressions 7-9 countries have almost equal weights).

The coefficients for risk aversion and uncertainty measures are generally positive and statistically significant. The magnitudes for the uncertainty measure on the yield spread are typically larger compared to the risk aversion measure (regression that do not include the lagged yield spread). For example regression 1 suggests that if the risk aversion measure increases by one standard deviation, the yield spread increases by 3,3 basis points whereas the corresponding number for increase in uncertainty measure is about 8,1 basis points. The magnitudes of both measures are larger in models which control the differences in CDS prices. These models, however, exclude the early and mid-2000´s from the sample. In this sense, the obtained larger magnitude might result from the larger variation in data. Moreover, when Ireland and Spain are excluded, uncertainty has not statistically significant relation on change in yield spread. In all specifications, the inclusion of country fixed effects does not change the results.

Descriptive evidence (see figures 10 and 11) and theoretical argument suggest that yield spreads and risk aversion and uncertainty measures are stationary time series.[3]As a robustness check, it is, however, examined whether the baseline result holds when the lagged yield spread is included to the model. In these regressions lagged spreads receive coefficients that are near to 1 which probably results from the small variation in daily level data. For this reason these regressions correspond to a model that estimates the difference in spreads. When the lagged spread is controlled, the risk aversion measures receives clearly smaller estimated coefficients compared to the regressions for spreads in levels. However, the coefficient for risk aversion remains to be positive and statistically significant. Moreover, regressions that control the lagged spreads result larger magnitudes for risk aversion

[3] Figures 10 and 11 show that time series lack any kind of long run trend. Also from the theoretical long run equilibrium viewpoint it is not plausible to expect that yield spreads, economic uncertainty or risk aversion are non-stationary variables.

compared to uncertainty. It seems that a rise in sovereign risk premium is more related to high risk aversion than high stock market uncertainty.

Before the latest financial crisis there is not statistically significant relationship between spreads and the level of investor risk aversion and stock market uncertainty. However, during the pre-crisis period the relation between change in yield spread and both measures is statistically significant. Surprisingly, the coefficient of uncertainty measure is negative during this time period, which in contrast to the theoretical prediction. It seems that the relationship between uncertainty and sovereign risk has been different during the pre- and post-crisis periods, which implies changes in investor preferences and attitudes toward this pricing factor.

The effect of investor sentiment can be seen economically significant. For example if the risk aversion increases by one standard deviation from its average level, which is fairly common movement during the sample period, the yield spreads increases by 20 percent points. In relative terms, this increase would result over 5 percent points higher average sovereign borrowing costs compared to Germany for the analyzed countries. In 2008, when the risk aversion reached its highest levels, the average impact of the investor sentiment was over 40 basis points which suggests that the average costs of investor sentiment were over 10 percent points higher compared to Germany in long term government bonds.

Overall, regression analysis finds that risk aversion is positively related to yield spreads. This result is robust in different sub-samples of the data and also when the assumption for constant fundamental risk is relaxed (differences in CDS prices are controlled).

Although the baseline result is in line with the theoretical prediction, the regression analysis is not able to detect the sign of the causality. There is a potential endogeneity issue that might arise, for example, from a possibility that the spreads also reflect the expectations on the future of the euro system. It might be the case that the yield spreads in the Eurozone´s sovereign debt markets affect the risk aversion and uncertainty in German stock markets. Next section examines the causality.

4.4 Causality

In order to study the direction of the causality and characterize the dynamic links between risk aversion, uncertainty and spreads, I turn to a simple vector autoregressive (VAR) system suggested by Sims (1980). VAR is a multiple equation model for joint determination of two

or more variables that is widely applied in macroeconometric analysis. A restricted VAR might include some variables in one equation, other variables in another equation. These restrictions and specifications are typically derived from economic theory. An unrestricted VAR includes all variables in each equation and it is fully data-driven method.

Although the presented consumption based asset pricing model predicts that the sign of the causality goes from the sentiment to the spreads, not another way round, it seems plausible that the causality might be bidirectional. This might be the case especially during the European sovereign debt crisis. For this reason the analysis is conducted with unrestricted VAR. Moreover, reported impulse responses are based on approach suggested by Pesaran and Shin (1998) which is invariant to the ordering of the variables in the VAR.

In this application pooling the countries is attractive choice because it increases the degree of freedom and potentially reduces the risk of overfitting. On the other hand pooling may introduce aggregation bias if the parameters for individual countries are heterogeneous. However, figure 9 show that the developments have been fairly homogeneous in all countries. For this reason country fixed effects and country specific coefficients are not included to the model.

VAR contains three endogenous variables; yield spread to Germany, risk aversion and uncertainty measures. Constant is included as an exogenous variable. Lag length is selected to be three by Akaike information criterion. The sample period is 2002-2014 and individual countries are included to the sample during the periods presented in table 3.

Panel A **Panel B**

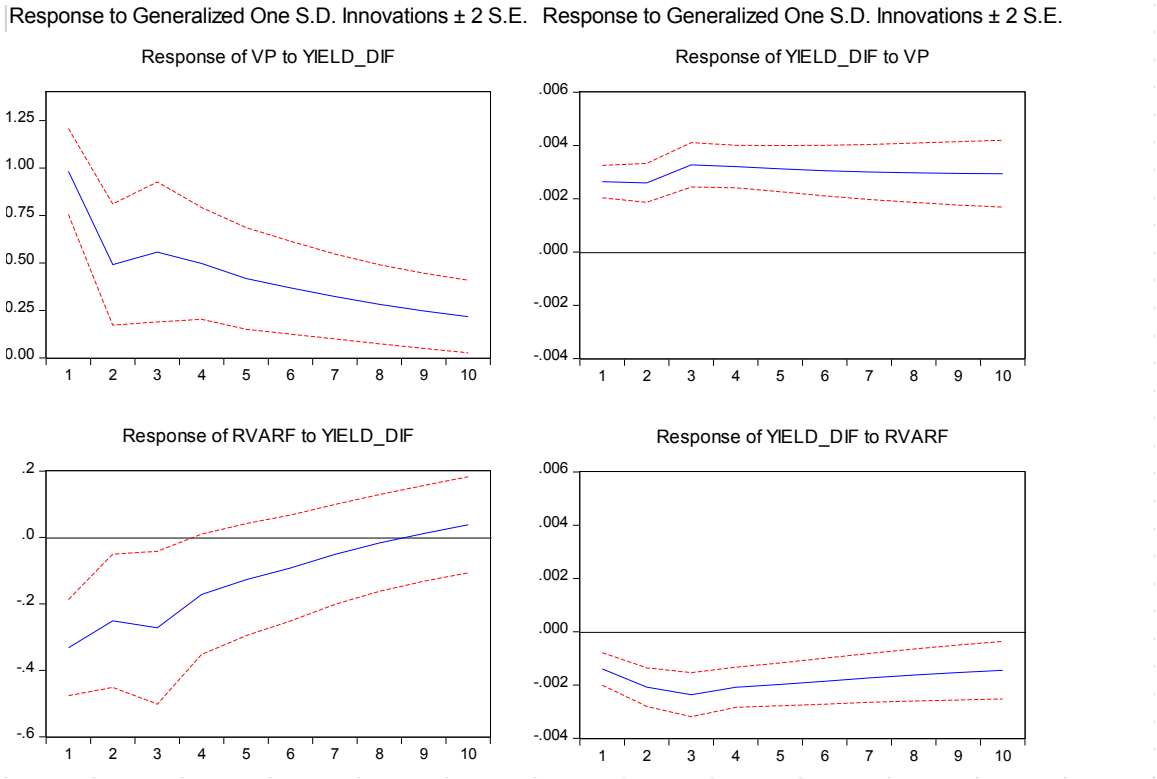

Figure 13. Impulse responses, daily frequency.

Panel A in figure 13 presents the impulse responses from risk aversion (VP) and uncertainty (RVARF) measures to yield spread. One standard deviation shock in risk aversion increases yield spread by one percent (100 basis points). Qualitatively this result is in line with the theoretical prediction and corresponds to the findings of the regression analysis. The effect is gradually decreasing but it is still positive and statistically significant after 10 days. This finding probably reflects the importance of the lagged spread which was observed in the regression analysis.

Surprisingly, the short term effect from uncertainty shock on yield spread is negative. However, the effect turns to be statistically insignificant after couple of days. The sign of the VAR estimate is negative for the first lag and positive for second and third lags. Panel B suggest that the causality is indeed bidirectional during the sample period, at least in short run. Shock in yield spread increase risk aversion and decrease uncertainty. However, the magnitudes are fairly small. VAR Granger causality tests support the conclusion of bidirectional causality between spread and risk aversion. Uncertainty seems to Granger cause spreads but not another way round.

Due to facts that the spreads have fairly low variation in the daily level data and investor sentiment has been considered as a persistent variable in the literature (see e.g. Brown and Cliff 2005), the corresponding VAR analysis is also conducted with monthly data in order to study the long run effects.

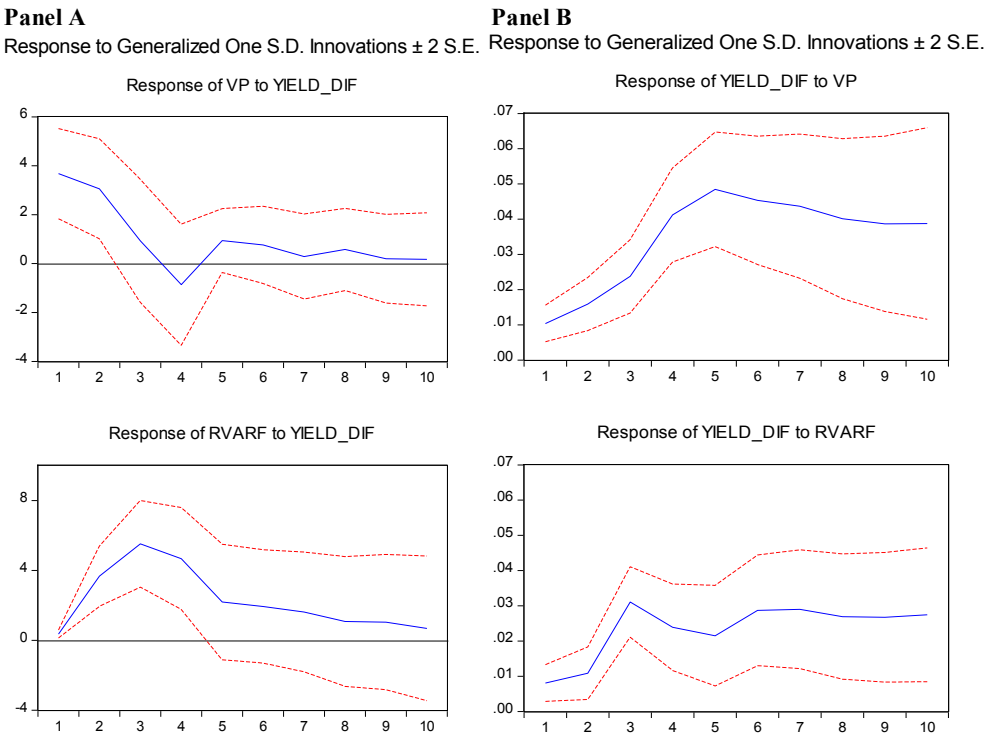

Figure 14. Impulse responses, monthly frequency.

Figure 14 shows that shocks in both risk aversion and uncertainty measures have positive impact on spreads. The effects are statistically significant after two and four months for risk aversion and uncertainty, respectively. The magnitudes of impulse responses are clearly higher compared to the previous analysis with daily level data. VAR Granger causality tests find that both risk aversion and uncertainty Granger causes spreads whereas spreads do not Granger cause risk aversion or uncertainty.

Overall, the VAR analyses find that shock in risk aversion increases yield spread. For uncertainty the evidence is somewhat mixed; in the short run the obtained impulse response on spreads is negative whereas the long run analysis results positive impact which in line with the theory. Moreover, the analysis suggests that the sentiment measures are not completely exogenous for yield spread in short run but the bidirectional causality does not hold with monthly data frequency.

4.5 Forecasting ability of the investor sentiment model

This section examines whether the risk aversion and uncertainty measures can be utilized to predict sovereign yield spreads. First I estimate a simple AR(1) model for yield spreads. This model is a benchmark that is compared to the model that includes lagged yield spread, risk aversion and uncertainty measures. More formally, the estimated benchmark model is:

$$y_{it} = c + p_y y_{it-1} + e_{it} \quad (17)$$

where y_{it} is a yield spread to Germany in country i at time t, y_{it-1} is a corresponding yield spread in previous time period, c is a constant (country fixed effects are not included) and e_{it} is the error term. This simple AR(1) has fairly good in-sample accuracy, the adjusted R-squared being 0,72 during pre-crisis period and 0,98 during the whole sample period. The competing sentiment model is:

$$y_{it} = c + p_y y_{it-1} + p_{VP} VP_{t-1} + p_{RVARF} RVARF_{t-1} + e_{it} \quad (18)$$

Where VP_{t-1} and $RVARF_{t-1}$ are the risk aversion and uncertainty measures at time $t-1$. The forecasting horserace is conducted with both daily and monthly data frequencies. For daily frequency, the evaluation of the predictive accuracy for both models is based on the one-year-ahead performance. The parameters $(c, p_y, p_{VP}, p_{RVARF})$ are estimated by using data for two years before the forecasted period. For monthly data the corresponding estimation and forecasting periods are three and two years, respectively.

The forecasting models are compared by using two alternative measures of forecasting accuracy, namely root mean squared error (RMSPE) and mean absolute percentage error (MAPE). Due to fact that all series are on the same scale and spreads are typically greater than zero MAPE is likely the most appropriate evaluation measure in this application (for comparison of the evaluation measures see e.g. Hyndman and Koehler, 2006).

Table 5: Out-of-sample forecasting accuracy of the benchmark and sentiment models, daily frequency, whole panel

Forecasted Year	Model	RMSPE	MAPE
2005	Benchmark	0,024	53,989
	Sentiment	0,023	52,939
	Improvement in accuracy (%)	**0,525**	**1,943**
2006	Benchmark	0,022	51,667
	Sentiment	0,022	52,131
	Improvement in accuracy (%)	**0,082**	**-0,897**
2007	Benchmark	0,029	31,474
	Sentiment	0,028	31,000
	Improvement in accuracy (%)	**1,447**	**1,504**
2008	Benchmark	0,067	16,658
	Sentiment	0,059	15,574
	Improvement in accuracy (%)	**12,981**	**6,504**
2009	Benchmark	0,055	6,416
	Sentiment	0,057	6,489
	Improvement in accuracy (%)	**-4,308**	**-1,148**
2010	Benchmark	0,035	8,057
	Sentiment	0,035	7,895
	Improvement in accuracy (%)	**0,231**	**2,012**
2011	Benchmark	0,051	7,197
	Sentiment	0,056	7,249
	Improvement in accuracy (%)	**-11,067**	**-0,727**
pre-crisis average	Benchmark	0,025	45,710
	Sentiment	0,024	45,357
	Improvement in accuracy (%)	**0,685**	**0,850**
crisis average	Benchmark	0,052	9,582
	Sentiment	0,052	9,302
	Improvement in accuracy (%)	**-0,541**	**1,660**

Table 5 reports the results from the forecasting horserace between the sentiment and benchmark models in daily frequency for all countries. In terms of RMSPE, both models provide clearly more accurate forecasts during the pre-crisis period (in 2005-2007) compared to the crisis period (in 2008-2011). In contrast, MAPEs are higher during the pre-crisis period and decrease significantly during the crisis period. Improvement in accuracy illustrates how much better (positive value) or worse (negative value) the sentiment model is compared to the benchmark in percentage terms according to both accuracy measure.

Overall, the results are somewhat mixed and the differences between forecasting abilities seem to be fairly small. In some years the sentiment model is more accurate whereas in other years its performance is worse. The results suggest that before and after the latest financial crisis the benchmark and sentiment model have almost equal accuracy when

predicting next day´s yield spreads. However, in 2008, the sentiment model clearly outperforms the benchmark by providing 13 (RMSPE) and 6,5 (MAPE) percent point more accurate forecasts compared to the benchmark.

The relatively small differences between the models might arise from the small variation in both yield spreads and sentiment measures in daily level data. Alternative explanation could be that the relationship between sentiment and yield spreads is time-varying. Notwithstanding, it seems that the sentiment model offers more accurate predictions during the periods of high risk aversion. In terms of MAPE, the correlation between accuracy improvement of the sentiment model and standard deviation of risk aversion measure being about 0,66 during the 2005-2011 period.

Table 6: Out-of-sample forecasting accuracy of the benchmark and sentiment models, daily frequency, individual countries

Country	Forecasted Year	Model	RMSPE	MAPE
Austria	2006	Benchmark	0,03	75,05
		Sentiment	0,03	73,29
		Improvement in accuracy (%)	**1,43**	**2,34**
	2010	Benchmark	0,05	7,52
		Sentiment	0,04	7,12
		Improvement in accuracy (%)	**0,62**	**5,41**
Finland	2006	Benchmark	0,03	73,64
		Sentiment	0,03	72,01
		Improvement in accuracy (%)	**-0,60**	**2,22**
	2010	Benchmark	0,04	14,87
		Sentiment	0,04	14,48
		Improvement in accuracy (%)	**2,69**	**2,59**
France	2006	Benchmark	0,01	18,99
		Sentiment	0,01	20,41
		Improvement in accuracy (%)	**-1,24**	**-7,48**
	2010	Benchmark	0,02	4,40
		Sentiment	0,02	4,57
		Improvement in accuracy (%)	**-1,40**	**-3,86**
Ireland	2006	Benchmark	0,01	23,52
		Sentiment	0,01	23,57
		Improvement in accuracy (%)	**-1,17**	**-0,23**
	2008	Benchmark	0,02	2,97
		Sentiment	0,02	2,96
		Improvement in accuracy (%)	**3,77**	**0,36**
Netherlands	2006	Benchmark	0,01	25,80
		Sentiment	0,01	28,51
		Improvement in accuracy (%)	**-47,75**	**-10,53**
	2010	Benchmark	0,02	5,46
		Sentiment	0,02	5,31
		Improvement in accuracy (%)	**0,32**	**2,65**
Spain	2006	Benchmark	0,03	80,83
		Sentiment	0,03	88,62
		Improvement in accuracy (%)	**-8,31**	**-9,63**
	2008	Benchmark	0,10	25,94
		Sentiment	0,09	24,91
		Improvement in accuracy (%)	**14,97**	**3,98**
Average	pre-crisis (2006)	Benchmark	0,02	49,64
		Sentiment	0,02	51,07
		Improvement in accuracy (%)	**-9,61**	**-3,88**
	crisis (2008 and 2010)	Benchmark	0,04	10,19
		Sentiment	0,04	9,89
		Improvement in accuracy (%)	**3,49**	**1,85**

When the comparison of the models is based on the evidence from the individual countries, the results are qualitatively similar to the previous analysis. Table 6 shows that before the crisis, in 2006, the benchmark outperforms the sentiment model in almost all countries. In 2008 and 2010 the sentiment model is clearly more accurate, France being the only exception. Compared to the previous analysis, the magnitudes of the difference between the models are clearly larger. In 2006, the sentiment model performs 3,9 (MAPE) to 9,6 (RMSPE) percent points worse compared to the benchmark. In contrast, during and after the crisis period (in 2008 and 2010), the sentiment model outperforms the benchmark by providing 3,5 (RMSPE) to 1,9 (MAPE) percent point more accurate forecasts.

It seems that the results are qualitatively similar for the all AAA-rated Eurozone countries. However, there exists significant heterogeneity in the magnitudes among the countries. In terms of RSMPE, the sentiment model offers clearly better prediction for Spain in 2008 (about 15 percent), whereas for Netherlands the benchmark model is exceptionally more accurate in 2006. These differences might result from the differences for example in bond liquidity, market structure, transaction costs or domestic investor preferences. The analysis of these issues is, however, left for future studies.

Table 7: Out-of-sample forecasting accuracy of the benchmark and sentiment models, monthly frequency, whole panel

Forecasted Period	Model	RMSPE	MAPE
2005-2006	Benchmark	0,03	2,52
	Sentiment	0,03	2,29
	Improvement in accuracy (%)	**0,29**	**9,13**
2006-2007	Benchmark	0,02	5,38
	Sentiment	0,03	2,94
	Improvement in accuracy (%)	**-8,16**	**45,35**
2007-2008	Benchmark	0,11	29,12
	Sentiment	0,09	27,36
	Improvement in accuracy (%)	**10,29**	**6,05**
2008-2009	Benchmark	0,17	23,93
	Sentiment	0,15	20,29
	Improvement in accuracy (%)	**13,29**	**15,19**
2009-2010	Benchmark	0,14	28,81
	Sentiment	0,13	23,71
	Improvement in accuracy (%)	**11,32**	**17,71**
2010-2011	Benchmark	0,11	15,42
	Sentiment	0,11	14,82
	Improvement in accuracy (%)	**0,99**	**3,88**
Average	Benchmark	0,10	17,53
	Sentiment	0,09	15,24
	Improvement in accuracy (%)	**4,67**	**16,22**

Table 7 reports the results of two-year-ahead forecasts for all countries with monthly frequency. The results suggest that the sentiment model clearly outperforms the benchmark. In contrast to the previous analyses with daily frequency, this observation holds for all forecasted periods. As with daily frequency, the improvement in forecast accuracy of the sentiment model is still the largest during the crisis period. During the 2005-2011 period the sentiment model has 16,2 (MAPE) to 4,7 (RMSPE) percent point better out-of-sample predictive ability compared to the benchmark. It seems that when the forecasting period is extended from daily to monthly level, the predictive power of investor sentiment and economic uncertainty on yield spreads increases significantly.

4.6 Discussion

Regression analysis finds that the risk aversion and uncertainty measures are positively related with yield spreads. During the times with low investor risk appetite and high stock market uncertainty, sovereign risk premiums typically rise in the triple-A-rated Eurozone

countries. It seems that the relationship between the spreads and risk aversion is persistent and it can be observed during both pre- and post-crisis periods, i.e. in both turbulent and serene market environments. This result is robust for the exclusion of the countries that experienced banking crisis during the late 2000´s and for the periods when rating events did not occur.

The estimated magnitudes for the measures suggest that the stock market uncertainty is probably more important factor for yield spreads than investors´ risk-appetite. However, change in yield spread seem to be more related to the level of risk aversion than uncertainty. Before the latest financial crisis, uncertainty has negative correlation with spreads which is in contrast to the theoretical prediction. It seems that during the pre-crisis periods, the uncertainty driven demand for safe assets actually converged the yields in the triple-A-tranche. During the crisis period uncertainty became a pricing factor that have had a positive impact on sovereign risk premiums. This suggests that investor preferences in government debt markets have changed during the crisis period.

Regressions that control the changes in expected default risk compared to Germany (difference in CDS prices) confirm the finding that there are developments in sovereign risk premiums that cannot be justified with economic fundamentals and that these developments are correlated with investor sentiment.

Qualitatively the baseline result from the regression analysis is in line with previous studies on European sovereign debt markets. For example Arghyrou, Kontonikas, 2012; Bernoth, Erdogan, 2012; Gerlach et al, 2010; Favero et al, 2010; Favero and Missale (2012) emphasize the role of global risk aversion in the widening of government bond spreads especially during the Eurozone sovereign debt crisis period. Moreover, Codogno et al. (2003) and Geyer et al. (2004) find that global risk aversion impacts yield spreads across EMU countries already before the crisis period.

The VAR analysis finds that there are causal relationship between yield spread and risk aversion, i.e. increase in risk aversion leads to higher yield spread. The magnitude of this effect is clearly higher compared to the OLS estimates. For uncertainty, the impulse responses are different in daily and monthly level analysis. The daily level analysis finds that increase in uncertainty decreases the yield spread whereas monthly level data provides opposite conclusion. In both analyses uncertainty Granger causes the yield spreads and not vice versa. In daily level analysis the causality between risk aversion and yield spread is

bidirectional. However, the impact of yield spread on risk aversion seem to be fairly small. In monthly level analysis the causality goes only from risk aversion to spreads.

Last, it was studied whether the so called sentiment model that contains information on risk aversion and uncertainty can provide better forecasts compared to simple AR(1) model. It seems that the sentiment model provides better predictions for the next day´s yield spreads only during the turbulent times. With monthly data frequency the sentiment model outperformed the AR(1) also during the pre-crisis periods. The results suggest that risk aversion and uncertainty have significant long run predictive power on spreads whereas in short run these measures do not provide valuable information for the forecasts. This result might arise from the fact in daily level data there are relatively small variation in spreads and the measures. Alternatively, the difference between the short and long run results might relate to the long run nature of the investor sentiment and arbitrage forces. According to Brown and Cliff (2005) the fact that sentiment appears to have little predictive power for near-term returns in empirical studies is probably because the importance of sentiment builds over time and short-run predictability would lead to a simple trading strategy generating abnormal returns.

Overall, the empirical analyses shows that investor risk appetite drives yield spreads in the triple A-rated Eurozone countries. This relationship seems to be robust and persistent during the sample period. The importance of the risk aversion as a pricing factor increases in the longer time horizon. For uncertainty economic theory suggests corresponding positive effect on risk premium. However, the obtained empirical evidence is mixed. It seems that the effect of uncertainty on sovereign risk premiums might be time varying.

Empirical studies that examine the impact of investor sentiment on asset prices face significant challenges in terms of identification; how to make sure that the observed price movements are related or caused by the investor sentiment or not just by some other factor. In order to overcome this problem, this study focuses on the safe assets which should have almost equal default risk. The rational arguments suggests that the fundamental based risk premiums between Germany and other triple-A-rated Eurozone countries should be relatively small and time invariant, probably driven mainly by the differences in liquidity. If an investor holds a bond to the maturity the expected payoff pattern should be similar for all bonds. Presented theoretical model suggests that in a case of twin-like-bonds with constant fundamental based risk premium, the yield spread should depend only on changes in

economic uncertainty and risk aversion (if the fundamental based risk premium is zero (bonds are "true twins") then the yield spread should always be zero).

However, the identification assumption can be questioned. It is plausible that especially during the financial and sovereign debt crisis a large share of investors disagree with the rating agency about the credit quality and require significant risk premium for the government bond, which drives the price down and increases the yield spread to Germany. For this reason it was studied whether the obtained baseline results hold when the identification assumption is relaxed. The possible time variation in default risk was controlled with CDS prices, which did not change the baseline results. In this sense it plausible to assume that the analysis was able identify the variation in government bond yields that was not related to the changes in economic or fiscal fundamentals.

Previous literature on determinants of sovereign yield spreads typically measures investor sentiment with VIX-index. As discussed in section 3, a stock market volatility index, however, harbors information on both risk aversion (sentiment) and uncertainty. By using the presented decomposition technique, this study is able to separate these factors for the European financial markets. However, the definition of investor sentiment is somewhat ambiguous and the measurement of the sentiment phenomena continues to be debated in the literature. Although, the analysis finds that the investor risk appetite has positive effect on yield spreads which is in line with theoretical prediction, I cannot rule out the possibility that the results are driven for example by the changes in other dimensions of investor preferences. It might be the case that investors have preferred German bonds due to reason that randomly coincide, but is not causally related, with risk aversion during the sample period.

The obvious disadvantage of the identification strategy is relatively low variation in the explanatory variable. Due to safe haven status, the yield spreads in the triple A-tranche government bonds have been fairly low even during the turbulent times. This low variation results low estimated magnitudes for the effect of investor sentiment. Although the evidence is based on the safest government bonds in the Eurozone, it is plausible to think that the results can be generalized to other assets as well. If the effect of investor sentiment on asset prices can be observed in the assets that are default risk free from the historical viewpoint, it is likely that the effect is clearly larger in riskier assets or asset classes. For example, the presented theoretical model suggests that the risk aversion enforces the fundamental based risk premium in a non-linear manner.

5 Conclusions

This master thesis examines the question that has been the subject of considerable debate in the finance literature; how investor sentiment affects asset prices. The empirical evidence is based on the sovereign yield spreads between Germany and other triple-A-rated Eurozone countries.

This study utilizes fairly recent and novel measure for investor risk aversion, the equity variance premium that is obtained with a decomposition method developed by Bekaert and Hoerova, and Lo Duca (2013). The variance premium for European financial markets is defined as a difference between the squared VDAX index and an estimate of the conditional variance of the German stock market, the DAX index. The decomposition of the volatility index provides measures for investor risk appetite and stock market uncertainty. During the analyzed time period, these measures are highly correlated with the observed flight-to-quality and flight-to-liquidity tendencies that are traditionally associated with changes in investor sentiment in the market place.

The presented simple asset pricing model suggests that when the fundamental based risk premium between two risky assets is constant, the yield spread is determined by the risk aversion and uncertainty. The empirical strategy is based on the assumption that the difference in default risk premium to Germany is time invariant in the triple-A-tranche. Compared to the bulk of previous studies on the determinants of sovereign yield spreads, this "twin-like-bond" design enables to use higher data frequency and improves the identification of the effect of the investor risk appetite. Moreover, previous studies that rely on market based measures typically use volatility index as a proxy for investor sentiment. Recent theoretical literature, however, suggests that volatility index harbors information on both risk aversion and uncertainty. The applied VDAX decomposition provides a way to examine the effects of these factors separately.

The main finding of this study is that the sovereign yield spreads are positively related to the level of risk aversion. During the times of low investor risk appetite the sovereign yield spreads to Germany increase. This finding holds for both pre- and post-crisis periods. Moreover, the VAR analysis suggests that this relationship is causal; changes in yield spreads are caused by investor risk aversion. In addition, it seems that the risk aversion and uncertainty measures have significant predictive power on next month´s yield spreads. The positive relationship between investor risk appetite and asset prices, especially in the US stock markets, is well documented by the previous research. This master thesis

contributes to the existing literature by providing new evidence that the sentiment phenomena can be observed also in the asset class that is often considered as a safe haven in the financial markets. This finding is line in with the studies that argue that the sentiment was important factor for sovereign yield divergence, especially in the peripheral countries, during the latest European debt crisis. However, this study finds that this relationship is persistent and it can be observed during the pre-crisis period and also in the triple-A-tranche.

The estimated magnitude for the effect of the investor sentiment is economically significant from the sovereign borrowing viewpoint. If the risk aversion measure increases by one standard deviation (which quite common movement during the sample period), triple-A rated Euro-sovereigns paid 5 percent points higher borrowing costs in long maturity debt claims compared to Germany. During the highest risk aversion in the crisis period, the corresponding average effect on relative borrowing costs is about 10 percent. This result suggests that in 2008 the Finnish government, for example, paid additional borrowing costs of 240 million euros that cannot be justified by increased sovereign default risk or other economic fundamentals.

The practical implications of the results are threefold. First, governments or companies that raise funding should acknowledge that the way how investors value the debt claim (or stock) and hence, what the funding costs would be, may largely depend on the phase of the sentiment cycle. When investors are highly risk averse, the required risk premiums might be clearly higher compared to the level that results from the fundamental based valuation, even when the issuer is financially in a good shape. Second, if the asset prices have tendency to return to the fundamental value when the high risk aversion wanes, the perception of the sentiment cycles might provide tempting investment opportunities for rational investor also in the relatively safe asset classes. Third, if the investor sentiment has profound and persistent impacts on asset prices, the burst of sentiment cycle might enforce financial crisis in a self-full filling manner (intuitively this kind of phenomena correspond to the bank run dynamics suggested by Diamond and Dybvig (1983)). In this situation fund raisers cannot improve their position in the financial markets by improving their fundamentals (for example government cannot decrease the risk premiums by cutting down the budget deficits) and hence, some kind of market intervention might be justified. For example Bekaert and Hoerova, and Lo Duca (2013) find that a lax monetary policy decreases both risk aversion and uncertainty.

This paper concludes that risk aversion has significant negative effect on asset prices also in the market segment of safe havens. However, more careful analyzes for the difference

between long and short run relationship, time varying nature of the effect of the uncertainty factor and sources for heterogeneity in risk aversion sensitivity among the countries might be useful avenues for the future research. This kind of analyzes could provide new insights on the functioning of the financial markets.

References

Acharya, V., Drechsler, I., Schnabl, P., 2011. A Pyrrhic Victory? – Bank Bailouts and Sovereign Credit Risk. NBER Working Paper, No. 17136.

Aizenman, J., Hutchison, M., Jinjarak, Y., 2013. What is the risk of European sovereign debt defaults? Fiscal space, CDS spreads and market pricing of risk, *Journal of International Money and Finance*, Vol. 34, pp. 37–59.

Arghyrou, M., Kontonikas, A., 2011. The EMU sovereign-debt crisis: fundamentals, expectations and contagion. European Commission Economic Paper, No. 436.

Baele, L., Bekaert, G., Inghelbrecht, K., 2013. Flights to Safety, NBER Working paper No. 19095, National Bureau of Economic Research, Inc., Cambridge, MA.

Baker M., Wurgler J., 2006. Investor sentiment and the cross-section of stock returns, *Journal of Finance* 61, pp. 1645-80.

Baker, M., Wurgler, J., 2007. Investor sentiment in the stock market. *Journal of Economic Perspectives*, 21(2), pp. 129-152.

Baker, M., Wurgler, J., Yuan, Y., 2012. Global, local, and contagious investor sentiment, *Journal of Financial Economics*, 104, pp. 272–287.

Bansal R., Yaron, R., 2004. Risks for the Long-Run: A Potential resolution of Asset Pricing Puzzles, *Journal of Finance* 59(4), pp. 1481-1509.

Barberis, N., Thaler, R., 2003. A survey of behavioral finance, Handbook of the Economics of Finance, in: G.M. Constantinides & M. Harris & R. M. Stulz (ed.), Handbook of the Economics of Finance, edition 1, volume 1, chapter 18, pp. 1053-1128 Elsevier.

Bekaert G., Hoerova, M., 2014. The VIX, the Variance Premium and Stock Market Volatility, *Journal of Econometrics* 183, pp. 181-192.

Bekaert G., Hoerova, M., Lo Duca, M., 2013. Risk, Uncertainty, and Monetary Policy, *Journal of Monetary Economics* 60, pp. 771-788.

Bekaert, G., Engstrom, E., Xing, Y., 2009. Risk, Uncertainty, and Asset Prices, *Journal of Financial Economics* 91, pp. 59-82.

Bernoth, K., Erdogan, B., 2012. Sovereign bond yield spreads: A time-varying coefficient approach, *Journal of International Money and Finance* 31, pp. 639–656.

Blommestein, H., Eijffinger, S., Zongxin, Q., 2012. Animal Spirits in the Euro Area Sovereign CDS Market, CEPR Discussion Papers No. 9092 (London: Centre for Economic Policy Research).

Bloom, N., 2009. The Impact of Uncertainty Shocks, *Econometrica* 77(3), pp. 623-685.

Bollerslev, T., Tauchen, G., Zhou, H., 2009. Expected Stock Returns and Variance Risk Premia, *Review of Financial Studies* 22(11), pp. 4463-4492

Brown, G., Cliff, M., 2004. Investor sentiment and the near-term stock market, *Journal of Empirical Finance* 11, pp. 1–27.

Brown G., Cliff M., 2005. Investor sentiment and asset valuation, *Journal of Business*, 78(2), pp. 405-40

Caballero, R., Krishnamurthy, A., 2008. Collective Risk Management in a Flight to Quality Episode, *Journal of Finance* 63(5), pp. 2195-2230.

Campbell, J., 2000. Asset pricing at the millennium. *Journal of Finance* 55, pp. 1515-1567.

Campbell, J., 2003. Consumption-Based Asset Pricing, in G. Constantinides, M. Harris, and R. Stulz (eds), Handbook of the Economics of Finance , North-Holland, Amsterdam, pp. 803–887.

Campbell, J., Cochrane, J., 1999. By Force of Habit: A Consumption Based Explanation of Aggregate Stock Market Behavior, *Journal of Political Economy* 107(2), pp. 205-251.

Candelon, B., Palm, F., 2010. Banking and Debt Crises in Europe: The Dangerous Liaisons?, *De Economist* 158, pp. 81-99.

Carr, P., Wu, L., 2009. Variance Risk Premiums. *Review of Financial Studies* 22 (3), pp. 1311-1341.

Chen, J., Hong, H., Stein, J., 2002. Breadth of ownership and stock returns. *Journal of Financial Economics* 66, pp. 171-205.

Codogno, L., Favero, C., Missale, A., 2003. Yield spreads on EMU government bonds, *Economic Policy*, pp. 505–532.

Coudert, V., Gex, M., 2008. Does Risk Aversion Drive Financial Crises? Testing the Predictive Power of Empirical Indicators, *Journal of Empirical Finance* 15, pp. 167-184.

Da, Z., Engelberg J., Gao, P., 2015. The sum of all FEARS: investor sentiment and asset prices, *Review of Financial Studies* 28, pp. 1–32.

De Grauwe, P., Ji, Y., 2013. Self-fulfilling crises in the Eurozone: an empirical test. *Journal of International Money and Finance* 34, pp. 15–36.

De Long, J., Shleifer A., Summers, L., Waldmann, R., 1990. Noise trader risk in financial markets, *Journal of Political Economy* 98, pp. 703-38.

Diamond, D., Dybvig, P., 1983. Bank runs, deposit insurance, and liquidity, *Journal of Political Economy* 91 (3), pp. 401–419.

Duffie, D., 2010. Is there a case for banning short speculation in sovereign bond markets?, Banque de France Financial Stability Review - Derivatives, Financial innovation and stability No. 14.

Edmans A., Garcia D., Norli, O., 2007. Sports sentiment and stock returns, *Journal of Finance* 62 (4), pp. 1967-98.

Favero, C., Missale, A., 2012. EU Public Debt Management and Eurobonds. EU

Parliament Economic Policy Note (Brussels: European Parliament).

Favero, C., Pagano, M., Thadden, E., 2010. How Does Liquidity Affect Government Bond Yields? *Journal of Financial and Quantitative Analysis*, 45(1), pp. 107–134.

Fontana, A., Scheicher, M., 2016. An analysis of euro area sovereign CDS and their relation with government bonds, *Journal of Banking & Finance* 62(C), pp.126-140.

Froot, K., Dabora, E., 1999. How are stock prices affected by the location of trade? *Journal of Financial Economics* 53, pp. 189-216.

Gerd, H., Lunde, A., Shephard, N., Sheppard, K., 2009. Oxford-Man Institute's realized library, Oxford-Man Institute, University of Oxford.

Gerlach, S., Alexander, S., Guntram, G., 2010. Banking and Sovereign Risk in the Euro area. Deutsche Bundesbank Discussion Paper No. 09/2010 (Frankfurt: Deutsche Bundesbank)

Geyer, A., Kossmeier, S., Pichler, S., 2004. Measuring Systematic Risk in EMU Government Yield Spreads, *Review of Finance* 8(2), pp. 171–197.

Harrison, M., Kreps, D., 1978. Speculative investor behavior in a stock market with heterogeneous expectations. *Quarterly Journal of Economics* 92, pp. 323-336.

Hirsheifer D., Shumway T., 2003. Good day sunshine: Stock returns and the weather, *Journal of Finance* 58, pp. 1009-1032.

Hong, H., Sraer, D., 2013. Quiet bubbles, *Journal of Financial Economics* 110(3), pp. 596 - 606.

Hyndman, J., Koehler, A., 2006. Another look at measures of forecast accuracy. *International Journal of Forecasting* 22, pp. 679–688

Jones, C., Lamont, O., 2002. Short-sale constraints and stock returns. *Journal of Financial Economics* 66, pp. 207-239.

Kamstra M., Kramer L., Levi M., 2003. Winter blues: A SAD stock market cycle, *American Economic Review* 93, pp. 324-43.

Kaplanski G., Levy H., 2010. Sentiment and stock prices: The case of aviation disaster, *Journal of Financial Economics* 95, pp. 174-201.

Kumar, A., Lee, C., 2006. Retail investor sentiment and return comovements, *Journal of Finance* 61, pp. 2451–2486.

Lamont, O., Thaler, R., 2003. Can The Market Add And Subtract? Mispricing In Tech Stock Carve-Outs, *Journal of Political Economy* 111(2), pp. 227-268,

Lamont, O., 2004. Going down fighting: short sellers vs. firms. Unpublished working paper. Yale Schoolof Management, New Haven, CT.

Lucas, R., 1978. Asset Prices in an Exchange Economy, *Econometrica* 46, pp. 1429–1445.

Manganelli, S., Wolswijk, G., 2009. What drives spreads in the euro area government bond market? *Economic Policy* 24, pp. 191–240.

Miller, E., 1977. Risk, uncertainty, and divergence of opinion. *Journal of Finance* 32, pp. 1151-1168.

Nagel, S., 2005. Short sales, institutional investors and the cross-section of stock returns. *Journal of Financial Economics* 78(2), pp. 277-309.

Pesaran, M., Shin, Y., 1998. Generalized impulse response analysis in linear multivariate models. *Economics Letters* 58, pp. 17–29.

Pu, X., Zhang, J., 2012. Sovereign CDS Spreads, Volatility, and Liquidity: Evidence from 2010 German Short Sale Ban, *Financial Review* 47(1), pp. 171-197.

Reed, A., 2003. Costly short-selling and stock price adjustments to earnings announcements. Working Paper, University of North Carolina, Chapel Hill, NC.

De Santis, R., 2012. The Euro Area Sovereign Debt Crisis: Safe Haven, Credit Rating Agencies and the Spread of the Fever from Greece, Ireland and Portugal, Working Paper No. 1419 European Central Bank, Frankfurt, Germany.

Scheinkman, J., Xiong, W., 2003. Overconfidence and speculative bubbles. *Journal of Political Economy* 111, pp. 1183-1219.

Shleifer, A., Vishny, R., 1997. The limits of arbitrage. *Journal of Finance* 52, pp. 35-55.

Schmeling, M., 2009. Investor sentiment and stock returns: some international evidence. *Journal of Empirical Finance* 16, pp. 394–408.

Schuknecht, L., von Hagen, J., Wolswijk, G., 2010. Government Bond Risk Premiums in the EU: Revisited the Impact of the Financial Crisis, ECB Working Paper No. 1152 (Frankfurt: European Central Bank).

Sims, C., 1980. Macroeconomics and reality, *Econometrica* 48 (1), pp. 1–48.

Standard & Poors, 2011. Sovereign Government Rating Methodology and Assumptions, Standard & Poors Financial Services LLC (S&P).

Ureche-Rangau, L., Burietz, A., 2013. One crisis, two crises… The subprime crisis and the European sovereign debt problems. *Economic Modelling* 35, 35–44.

Whaley, R., 2000. The Investor Fear Gauge, *Journal of Portfolio Management*, pp. 12-17.